November 10, 1958

# Aviation Week

## Including Space Technology

**McDonnell 120 Design Details**

•

**Ferrite Cores Reduce Circuitry**

De Havilland DHC-4 Caribou

It takes smart maneuvering to stay ahead in the highly competitive airframes fastener industry. It takes originality! Improvements! Refinements!

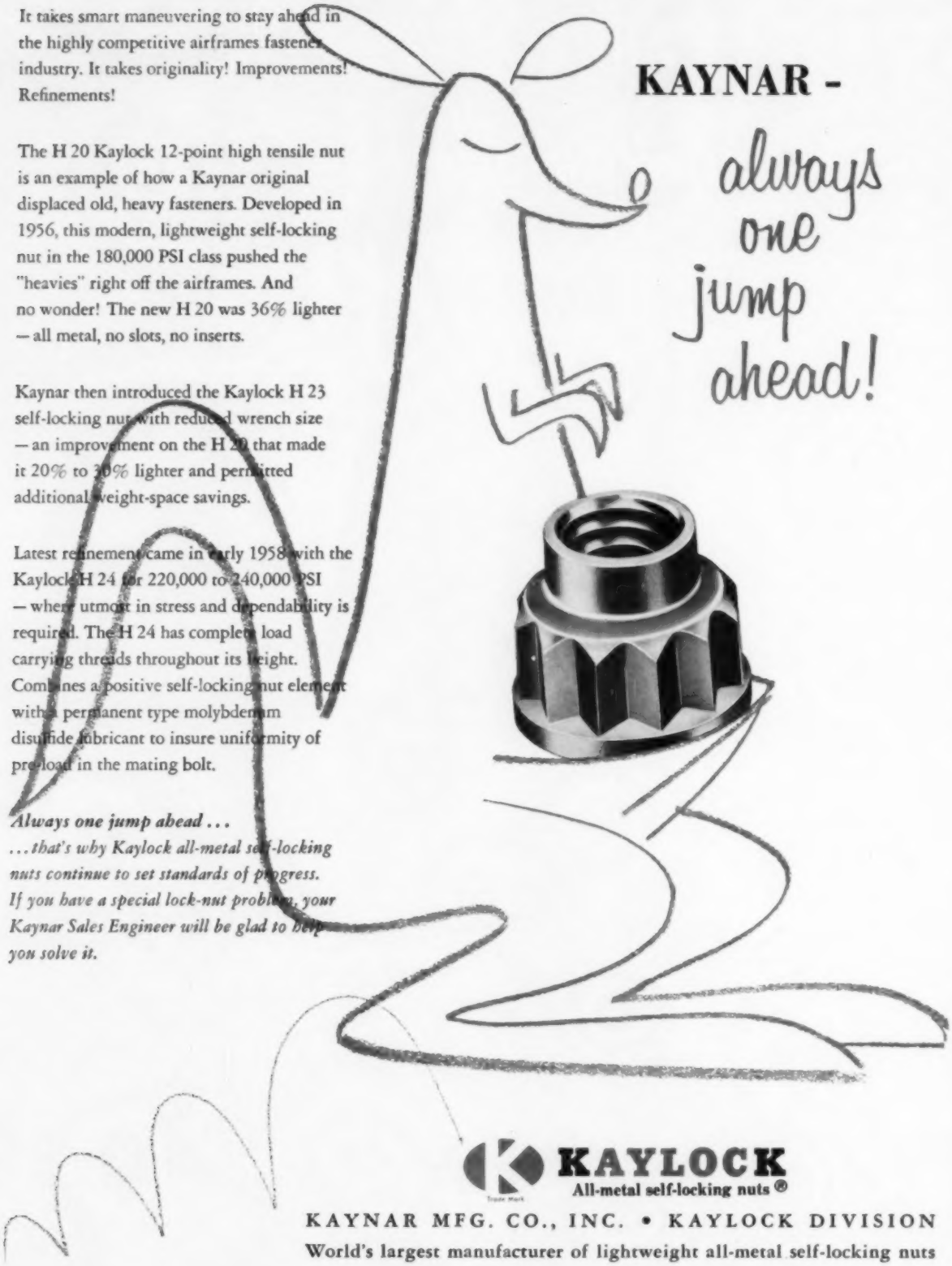
The H 20 Kaylock 12-point high tensile nut is an example of how a Kaynar original displaced old, heavy fasteners. Developed in 1956, this modern, lightweight self-locking nut in the 180,000 PSI class pushed the "heavies" right off the airframes. And no wonder! The new H 20 was 36% lighter — all metal, no slots, no inserts.

Kaynar then introduced the Kaylock H 23 self-locking nut with reduced wrench size — an improvement on the H 20 that made it 20% to 30% lighter and permitted additional weight-space savings.

Latest refinement came in early 1958 with the Kaylock H 24 for 220,000 to 240,000 PSI — where utmost in stress and dependability is required. The H 24 has complete load carrying threads throughout its height. Combines a positive self-locking nut element with a permanent type molybdenum disulfide lubricant to insure uniformity of pre-load in the mating bolt.

***Always one jump ahead . . .***
*. . . that's why Kaylock all-metal self-locking nuts continue to set standards of progress. If you have a special lock-nut problem, your Kaynar Sales Engineer will be glad to help you solve it.*

# KAYNAR - always one jump ahead!



**KAYLOCK**
All-metal self-locking nuts ®

**KAYNAR MFG. CO., INC. • KAYLOCK DIVISION**
**World's largest manufacturer of lightweight all-metal self-locking nuts**

Home office & plant: Write Box 2001, Terminal Annex, Los Angeles 54
Branch offices, warehouses and representatives in Wichita, Kansas, New York, N. Y., Atlanta, Georgia. Canadian distributor: Abercorn Aero, Ltd., Montreal, Quebec

©Kaynar Mfg. Co., Inc., 1958

NOSE CONES—One of the Prime Capabilities of

# Answer to the Problem of Re-entry:

**NOSE CONES OF SPECIAL MATERIALS —ENGINEERED BY GOODYEAR AIRCRAFT**

To spearhead a ballistic missile calls for engineering ingenuity to solve the re-entry problem.

Shown here is a nose cone fabricated of a classified material developed through the teamwork of the Army Ballistic Missile Agency and the engineering skill of Goodyear Aircraft Corporation.

Result: the Army's Jupiter—and other ballistic missiles of the future—will look to Goodyear-built nose cones to bear the brunt of white-hot re-entry into the earth's atmosphere.

Such performance is the result of applied engineering in which Goodyear Aircraft has been a standout for many years. These skills are backed by huge manufacturing facilities including mammoth presses to mass-produce this product.

Let these skills solve your special problems. Write, today and *now*, to Goodyear Aircraft Corporation, Dept. 916 AW, Akron 15, Ohio.

**GOODYEAR AIRCRAFT**

*Plants in Akron, Ohio, and Litchfield Park, Arizona*

SYSTEMS ENGINEERING
RAYTHEON
RESEARCH
PRODUCTION
RAYTHEON
QUALITY CONTROL
FIELD SUPPORT
PROGRAM MANAGEMENT
How to assign
complete responsibility for
WEAPON SYSTEM MANAGEMENT
Raytheon's broad experience in radar, countermeasures, missile guidance, sonar, communications, navigation—electronic equipment of every kind—is assurance of competence to shoulder *complete* system management responsibility.
Over 32,000 skilled scientists, engineers and assemblers, working with some of the most advanced facilities in the industry, have built Raytheon's reputation for "Excellence in Electronics".
RAYTHEON MANUFACTURING COMPANY
Waltham, Massachusetts

## AVIATION CALENDAR

Nov. 16-21—Conference on Scientific Information, Mayflower Hotel, Washington, D. C. Co-sponsored by USAF Office of Scientific Research, National Academy of Sciences, National Science Foundation and American Documentation Institute.

Nov. 17-18—Sixth Annual Aircraft and Missile Division Conference, American Society for Quality Control, Biltmore Hotel, Dayton, Ohio.

Nov. 17-21—13th Annual Meeting and Astronautical Exposition, American Rocket Society, Hotel Statler, New York, N. Y.

Nov. 17-21—Eighth National Plastics Exposition, International Amphitheatre, and Plastics Conference, Hotel Morrison, Chicago, Ill.

Nov. 19-20—Northeast Electronics Research and Engineering Meeting, Mechanics Hall, Boston, Mass.

Nov. 19-21—32nd Meeting, Aviation Distributors and Manufacturers Assn., Statler Hilton Hotel, Dallas, Tex.

Nov. 21-22—Third Symposium on Magnetohydrodynamics. Lockheed Missile Systems Division's Research Laboratory, Palo Alto, Calif. Attendance by invitation.

Nov. 28—Fourth Convertible Aircraft Congress, the Franklin Institute, Philadelphia, Pa.

Nov. 28-30—Snowbird Soaring Meet, Harris Hill, Elmira, N. Y.

Nov. 28-Dec. 4—First Electronic Computer Exhibition and Symposium, Olympia, London, England.

Dec. 1-5—Annual Meeting, American Society of Mechanical Engineers, Hotels Statler-Hilton and Sheraton-McAlpin, New York, N. Y.

Dec. 2-4—Third Conference on Reliable Electrical Connection, sponsored by Electronic Industries Assn., Dallas, Tex.

Dec. 3-5—Second National Symposium on

(Continued on page 6)

AVIATION WEEK Including Space Technology

November 10, 1958
Vol. 69, No. 19

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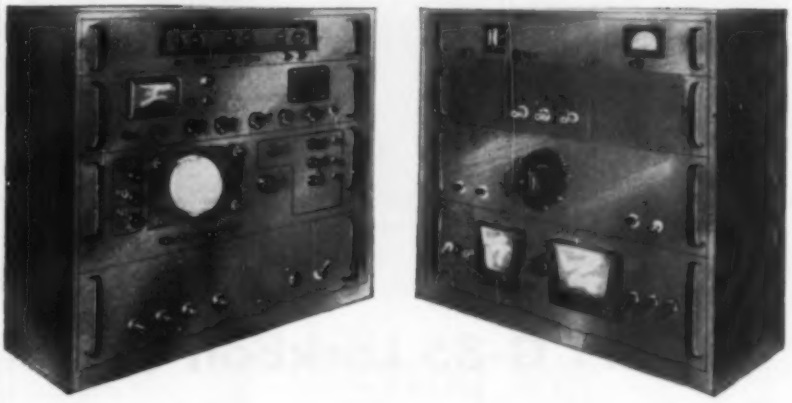
*Progress in the Science of Chronometry*

IN 1714, the British government offered a prize of £20,000 for any means of determining a ship's longitude within 30 nautical miles at the end of a six week's voyage. John Harrison, a self-educated Yorkshire carpenter, won the prize in 1760 with an accurate clock.

IN 1958, ICBMs and earth satellites created the need for new concepts in accurate timing. To fill this need, Hycon Eastern has developed an electronic Timing System with heretofore unattainable timing precision capable of operating anywhere in the world.

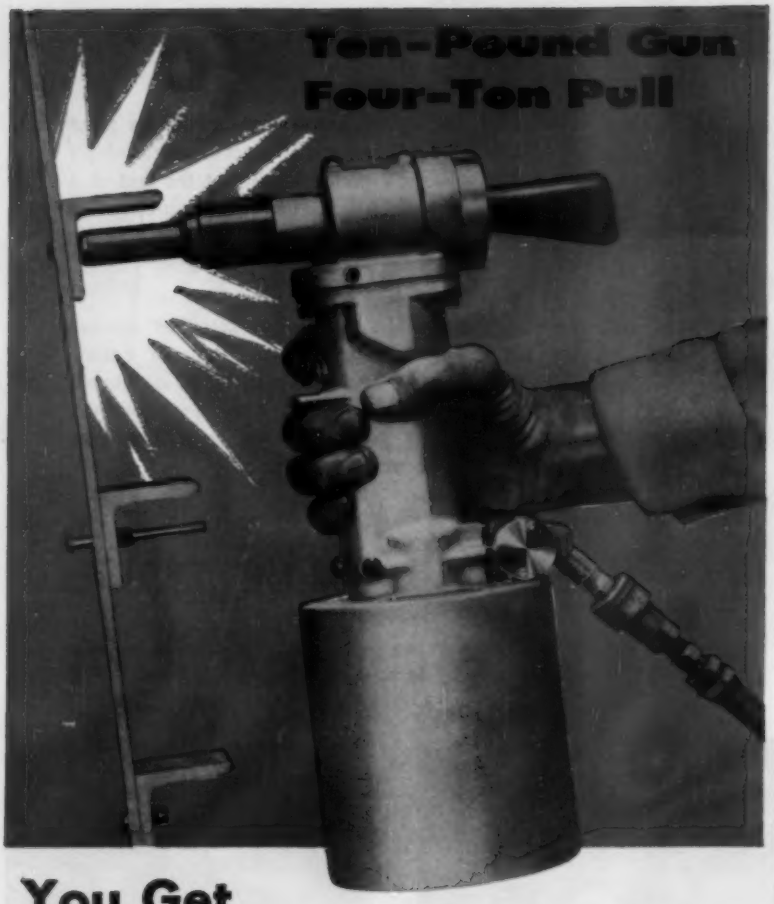
**AN INTEGRATED TIMING SYSTEM FOR TODAY'S GLOBAL CONCEPTS**



Solar or sidereal time is displayed visually and is available for input to automatic computers and indexing data with many types of recorders . . . magnetic tape, oscillograms, photographs and strip charts. Furnishing a time scale with resolutions available to one microsecond, this system is ideally suited for tracking and control of missiles, astronomical measurements, and navigation systems. Write for Bulletin TS-00.

**HYCON EASTERN, INC.**

75 Cambridge Parkway Dept. W Cambridge 42, Massachusetts




# You Get MORE POWER—Less Weight with the *New* CHERRY G-85 Lockbolt Gun

The new Cherry G-85 lockbolt gun is designed to give you maximum pulling power with less weight. Its simplified rugged construction assures low maintenance costs. The gun weighs only 10.5 pounds, which reduces operator fatigue.

No special air supply is required with this lightweight gun, because it develops this high capacity at normal line pressure.

As the leader in the field of special aircraft fasteners, Cherry Research and Development department has produced this new lightweight, high capacity gun to increase the efficiency of installing lockbolts.* The G-85 gun may be adapted for setting stainless steel, monel, aluminum and carbon steel Cherry blind rivets.

For information on the new Cherry G-85 gun write Townsend Company, Cherry Rivet Division, Post Office Box 2157-N, Santa Ana, California.

*Licensed under Huck patents RE22,782; 2,114,403; 2,527,307; 2,531,048; 2,531,049 and 2,754,703

**CHERRY RIVET DIVISION**

**Townsend Company**

## AVIATION CALENDAR

(*Continued from page 5*)

Global Communications, sponsored by the Institute of Radio Engineers and American Institute of Electrical Engineers, Colonial Inn, St. Petersburg, Fla.

**Dec. 3-5**—Eastern Joint Computer Conference and Exhibit, Bellevue-Stratford Hotel, Philadelphia, Pa.

**Dec. 4-5**—Ninth National Conference, Professional Group on Vehicular Communications, Institute of Radio Engineers, Hotel Sherman, Chicago, Ill.

**Dec. 9-11**—Mid-America Electronics Convention, sponsored by Kansas City Section, Institute of Radio Engineers, Municipal Auditorium Arena, Kansas City, Mo.

**Dec. 17**—22nd Wright Brothers Lecture, Maurice Roy on French aeronautical research, Natural History Bldg., Smithsonian Institution, Washington, D. C.

**Dec. 27-30**—Fifth Annual Meeting, American Astronautical Society, Hotel Statler, Washington, D. C. Meeting will be held in conjunction with the 125th Annual Meeting of the American Assn. for the Advancement of Science.

**Jan. 12-14**—Fifth National Symposium on Reliability and Quality Control in Electronics, Bellevue-Stratford Hotel, Philadelphia, Pa.

**Jan. 19-21**—11th Annual Convention, Helicopter Assn. of America, Villa Hotel, San Mateo, Calif.

**Jan. 21-23**—South West Electronic Exhibit, Arizona State Fairgrounds, Phoenix, Ariz.

**Jan. 26-29**—27th Annual Meeting, Institute of the Aeronautical Sciences, Sheraton-Astor Hotel, New York, N. Y. Honors night Dinner, Jan. 27.

**Jan. 27-29**—Fifth Annual Radar Symposium (classified), Rackham Bldg., University of Michigan, Ann Arbor, Mich.

**Jan. 27-30**—15th Annual Technical Conference, Society of Plastics Engineers, Hotel Commodore, New York, N. Y.

**Feb. 3-5**—14th Annual Technical and Management Conference, Reinforced Plastics Division, Society of the Plastics Industry, Inc., Edgewater Beach Hotel, Chicago, Ill.

**Feb. 12-13**—1959 Solid State Circuits Conference, sponsored by Institute of Radio Engineers' Professional Group on Circuit Theory, American Institute of Electrical Engineers' Committee on Electronics and the University of Pennsylvania, Philadelphia, Pa.

**Feb. 21-22**—13th Annual Pacific Coast Mid-Winter Soaring Championships, Torrey Pines Gliderport, San Diego, Calif.

**March 3-5**—1959 Western Joint Computer Conference, sponsored by Institute of Radio Engineers, American Institute of Electrical Engineers and Assn. for Computing Machinery, Fairmont Hotel, San Francisco, Calif.

**March 5-6**—Flight Propulsion Meeting (classified), Institute of the Aeronautical Sciences, Hotel Carter, Cleveland, Ohio.

**March 8-11**—Engineering meeting on the turbine in action, sponsored by Gas Turbine Division of the American Society of Mechanical Engineers, Cincinnati, Ohio.

# HAPPY HOLIDAYS VIA EASTERN

Lured by the prospect of Happy Holidays, thousands of people are flying via Eastern Air Line's Great Silver Fleet. Behind every flight is Eastern's painstaking maintenance program that starts with materials testing... and ends with selection of the finest products available.

This special care in using only the best is one of the reasons why Eastern is using Sinclair Aircraft Oils *exclusively* for the tenth year. Many millions of air miles have proved that Sinclair lubricants provide dependable aircraft lubrication. Why don't *you* rely on Sinclair Aircraft Oils for reliability—economy?

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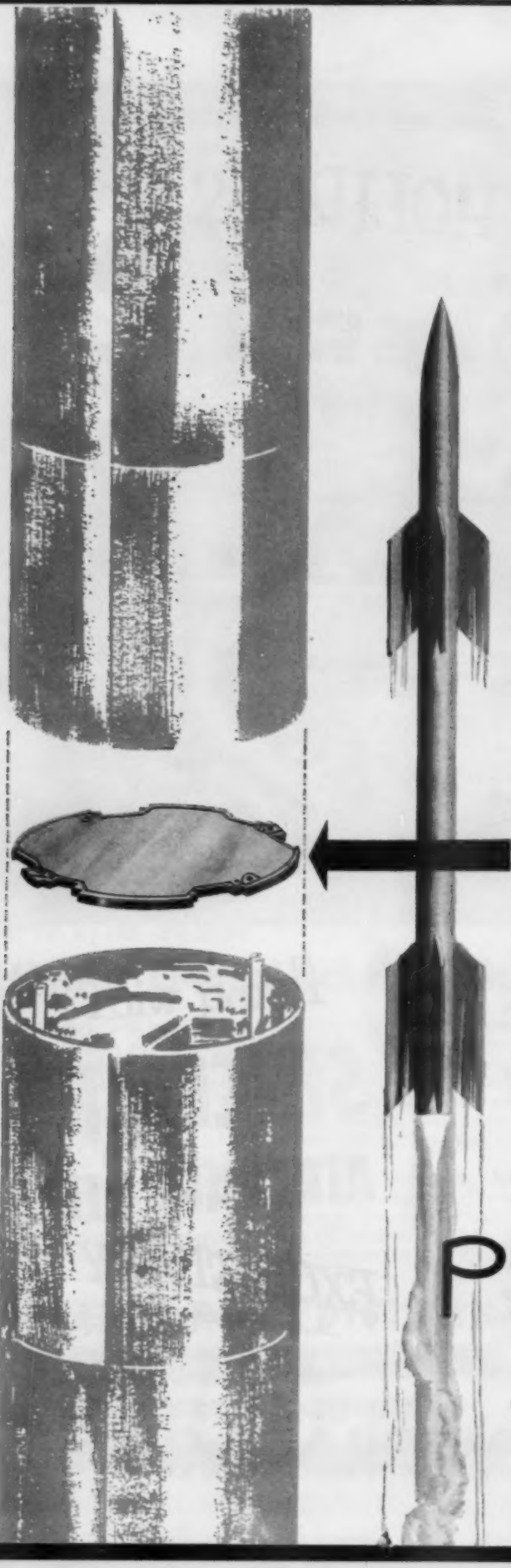
## SINCLAIR AIRCRAFT OIL EXCLUSIVELY

## SINCLAIR AIRCRAFT OILS

Sinclair Refining Company, Aviation Sales, 600 Fifth Avenue, New York 20, N.Y.



Do you know about Gask-O-Seals?

# THIS Gask-O-Seal

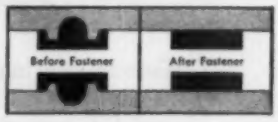
## EXCEEDS HERMETIC SPECS!

Gask-O-Seals often equal or exceed *specification for hermetic* sealing. The one shown here, for instance, has eight sealing points and is on one of our newest missiles. The leakage rate is less than the original *hermetic* seal specification called for which is about as perfect as any seal can be.

Gask-O-Seals are high and low pressure static seals which require NO groove machining to accommodate. A flat surface with only a 125 RMS surface finish is all you have to provide to get positive sealing with a Gask-O-Seal.

There are many other outstanding features about Gask-O-Seals: Limited area for fluid attack, no loss of structural strength, rigid, easy to install and replace, no tolerance build-up possible in seal cavity, etc.

Why not find out about Gask-O-Seals and the other seals of Parker Seal Company's "O-Seal Family"—by the makers of Parker O-rings.

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SEAL COMPANY
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A DIVISION OF Parker Hannifin CORPORATION
(Formerly F. C. Wolfe Co. & Rubber Products Div. of Parker Appliance Co.)

# READ* BY

# Temco

AIRCRAFT
DALLAS

***Radar Echo Augmentation Device—**
Temco's black box with the brilliant future in radar electronics. A radically new system which can augment its carrier's radar cross section from zero up to 60 square meters, greatly increasing its visibility on radar sets, READ is the product of years of basic microwave research.

The READ system weighs approximately 10 pounds and can be installed in nearly all drones built to date. A new traveling-wave tube amplifier application, READ is effective with either PPI or A-scope radar. A single unit will cover the entire S-band or X-band, and can be used in bistatic systems (in which the transmitter and receiver are located at different points).

The development and production of READ is representative of Temco's advanced capabilities in microwave technology, growing as rapidly and substantially as the industry it serves. Temco's complete systems capabilities are ready to meet **your** challenge.

**Patent Pending*

DECOYS

MISSILE TRACKING

TARGET SYSTEMS

PROXIMITY WARNING

AIR TRAFFIC CONTROL

TOMORROW'S NEED IS TODAY'S CHALLENGE AT..

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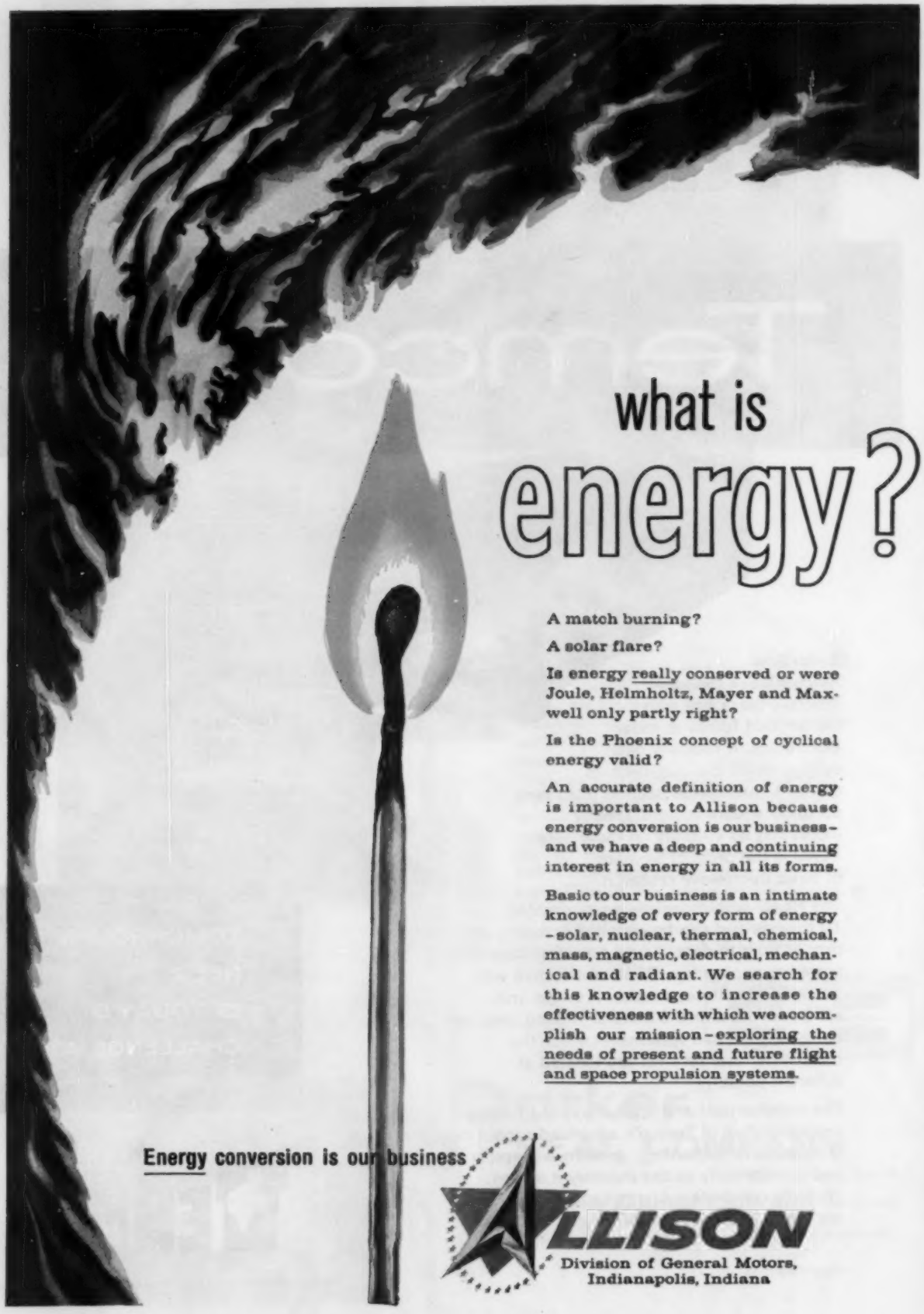
AIRCRAFT CORPORATION · DALLAS, TEXAS



# what is energy?

A match burning?

A solar flare?

Is energy <u>really</u> conserved or were Joule, Helmholtz, Mayer and Maxwell only partly right?

Is the Phoenix concept of cyclical energy valid?

An accurate definition of energy is important to Allison because energy conversion is our business–and we have a deep and <u>continuing</u> interest in energy in all its forms.

Basic to our business is an intimate knowledge of every form of energy–solar, nuclear, thermal, chemical, mass, magnetic, electrical, mechanical and radiant. We search for this knowledge to increase the effectiveness with which we accomplish our mission–<u>exploring the needs of present and future flight and space propulsion systems</u>.

**<u>Energy</u> conversion is our business**

**ALLISON**
Division of General Motors,
Indianapolis, Indiana

# WEATHERHEAD

*Announces*

# AVIATION & MISSILE GROUP

## to better SERVE the accelerated SPACE AGE

Weatherhead announces a new Aviation and Missile Group comprised of three plants strategically located to speed the development and production of vital aircraft and missile hydraulic and pneumatic components.

Located in the heart of the west coast aircraft and missiles industry, the Western Aviation Division in Glendale, California, will be expanded to specialize in the development of fittings and valves and the manufacture of short lead time production items.

The mid-west operation headquartered in Cleveland, Ohio, will concentrate its facilities on volume production items. A research and development center will devote its efforts to the development of flexible fluid line assemblies, hydraulic actuators, and fluid valves and pressure vessels for the advanced hydraulic, pneumatic and fuel systems of today's aircraft and missiles.

The Eastern Aircraft Products Corporation, a Weatherhead subsidiary in Orange, New Jersey, will specialize in quick disconnect couplings and special valves of similar construction.

Ready to meet the ever increasing demands imposed by our accelerated space age, each of these plants will be autonomous and organizationally complete, offering fully integrated engineering, manufacturing and sales facilities on a local, regional level.

## WEATHERHEAD AVIATION and MISSILE GROUP

WESTERN DIVISION
1736 Standard Avenue
*Glendale, California*

SPECIAL PRODUCTS DIVISION
300 East 131st Street
*Cleveland, Ohio*

EASTERN AIRCRAFT PRODUCTS CORP.
229 River Street
*Orange, New Jersey*

**First manned U.S. space probe ship, the X-15,** will make a red-hot reentry into earth's atmosphere — but it's designed to avoid burning up. Skin is made of Inconel "X" alloy.

# How X-15's red-hot comeback will be handled

As X-15 streaks in from space, air friction heats its nose, leading edges to a dull glowing red in seconds. Even side panels reach about 1000° F! If skin weakens too much, air loads tears it off the ship.

In these highly stressed skin areas, designers of the X-15 use Inconel "X"* age-hardenable nickel-chromium alloy. It has high-temperature strength and heat resistance, plus high-temperature creep resistance.

After forming, X-15's skin is thinned to specification by chemical milling. The process, Chem-Mill**, was developed by the ship's manufacturer, North American Aviation, Inc.

Following acceptance flight tests, the rocket-powered X-15 will be turned over to the Air Force, Navy, and National Advisory Committee for Aeronautics.

Perhaps one of the standard Inco Nickel Alloys will help your products get off the ground — and back — safely. Talk it over with the Inco Development and Research Division.

*Registered trademark
**T. M. North American Aviation, Inc.

**THE INTERNATIONAL NICKEL COMPANY, INC.**

67 Wall Street — New York 5, N. Y.

INCO
TRADE MARK

## INCO NICKEL ALLOYS

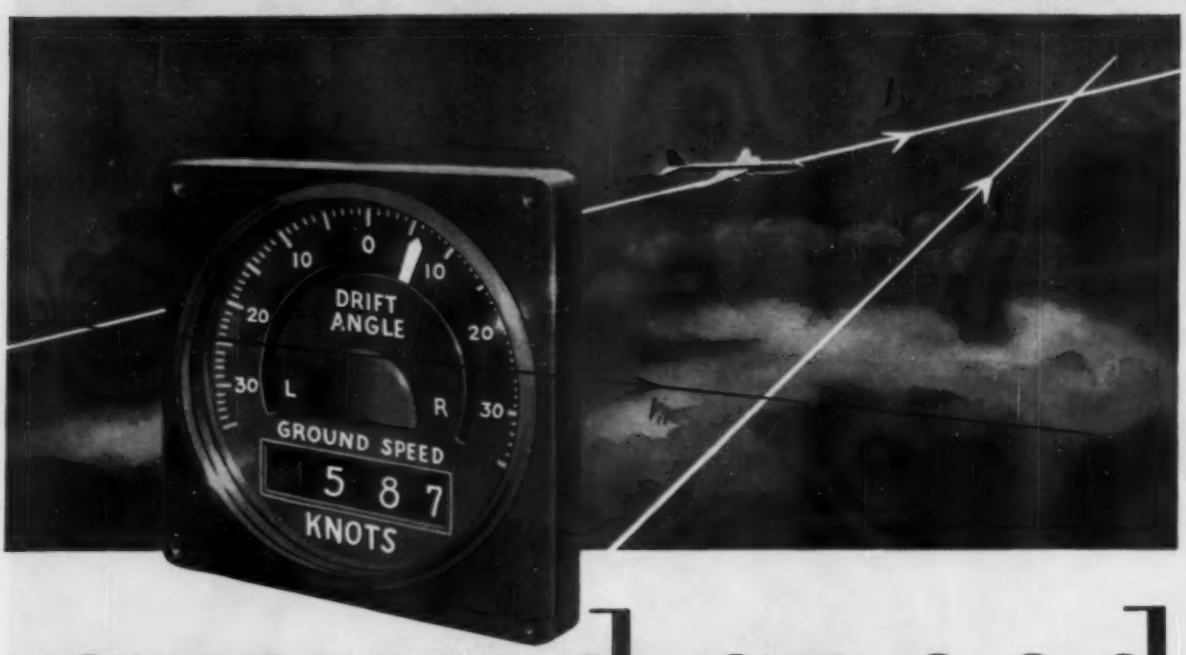
U.S. AIR FORCE
NORTH AMERICAN X-15

One of GPL's ground speed and drift angle measuring equipments, AN/APN-81, provides basic input information to computers which tell Air Force WB-50s exactly where they are every flight second.

GPL auto-navigators give an instantaneous and continuous display: Ground Speed and Drift Angle; Wind Speed and Direction; Longitude and Latitude; Shortest Course-To-Destination; Steering Signal To Pilot (or autopilot).

The systems were developed for the Air Force (WADC). They are the result of an achievement comparable in magnitude to the breaking of the sound barrier: GPL's harnessing of the Doppler-effect to air navigation.

The benefits of these GPL systems extend to every area of flight. Their vast potential has just begun to be explored.




# ground speed & drift angle

## ANY TIME, ANYWHERE, ANY WEATHER

One look and the pilot KNOWS. At a glance, he reads actual ground speed and drift angle, displayed on his flight panel – automatically, accurately, and continuously.

How? Through the famous RADAN* family of self-contained GPL Doppler auto-navigators, recently released for civilian use.

For civilian aircraft, RADAN systems mean pinpoint navigation, reliability, savings in precious time and fuel, a priceless margin of safety. In its wide and growing applications for the military, RADAN provides all these, and continuous velocity data as well.

GPL systems have behind them many millions of operational miles in transcontinental, oceanic and polar flight. RADAN systems herald a new era of faster, safer, more economical civilian flight.

RADAN is ready and available *now* to everyone.

GPL | GENERAL PRECISION LABORATORY CORPORATION

GENERAL PRECISION LABORATORY INCORPORATED, Pleasantville, N. Y.

*Trademark

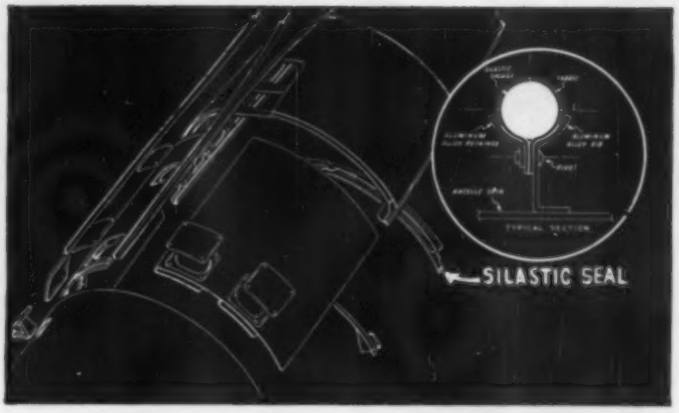
ENGINEERS – GPL achievements have opened up some unusual research and development opportunities. Send resumé to Personnel Manager.

## The PLANE

U. S. Navy's Douglas A3D Skywarrior, twin-jet attack bomber. An extremely powerful carrier-based craft, the A3D can deliver nuclear bomb loads. It is capable of high subsonic speeds and has held the round-trip transcontinental speed record. In production at El Segundo division of Douglas Aircraft Co.

## The PROBLEM

Maintaining an effective cowl seal on the Pratt & Whitney J57 engine nacelles. High engine heat within and the extreme cold of upper altitudes require the seal to stay resilient despite widely varying temperatures. Seal material should also resist salt spray, ozone and weathering.




## The PART

## SILASTIC

SILICONE RUBBER

Sponged Silastic®, the Dow Corning silicone rubber, more than meets these difficult demands. Sponge of Silastic keeps its shape, holds firm seal under severe conditions.

TYPICAL PROPERTIES OF SPONGED SILASTIC

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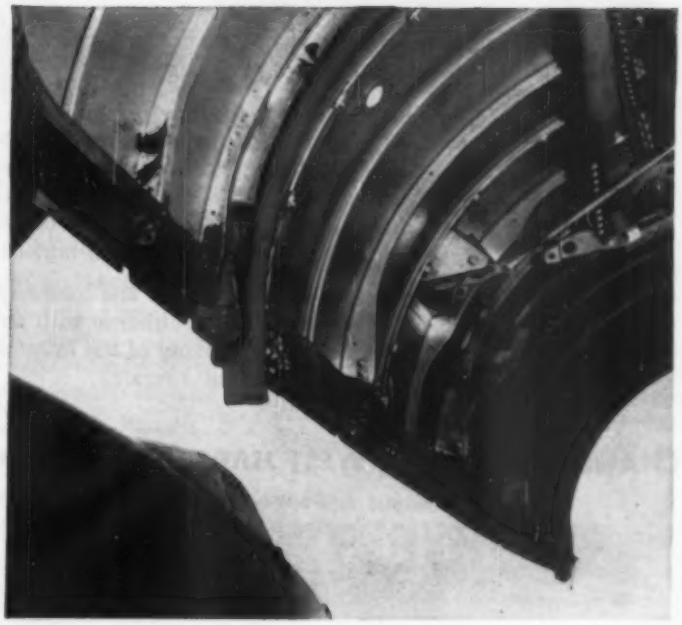
|---|---|
| Temperature range, °F . . | —130 to 500 |
| Ozone resistance . . . . | excellent |
| Structure . . . . . | Closed cell |
| Specific Gravity . . . . . | As low as 0.25 |

For more information, write Dept. 0911.



first in silicones

**Dow Corning**
**CORPORATION**
MIDLAND, MICHIGAN

FROM AN ORIGINAL PAINTING FOR CECO BY R. T. HANDVILLE

**Contributing to superb performance . . .** Boeing's 707 Jetliners powered by Pratt & Whitney Aircraft JT-3 turbojets will be equipped (as will many of the JT-4 applications) with *main fuel pumps* engineered and built by Chandler-Evans. CECO, in addition, is producing *cabin temperature control valves* for a number of the 707s which have been ordered by world-famous air lines.

Products, too, are "known by the company they keep", and CECO is proud to be airborne with an array of important missiles as well as with many of the latest and finest military and commercial aircraft.

**CHANDLER-EVANS • WEST HARTFORD 1, CONNECTICUT**

***Interesting, informative literature on many CECO products is yours for the asking. Please address your request to Department 48.***

CECO
SYSTEMS
CONTROLS

# COUNT DOWN

*for the conquest of space*

## IS THE ROCKET ENGINE MAN'S ONLY WAY TO OUTER SPACE?

Strapped and cushioned against the relentless grip of acceleration, a man lies supine and helpless as his crew of robot devices controls the upward drive of his ship. He watches the firing seconds tick away—300 ... 450 ... 600—until suddenly, both sound and acceleration stop simultaneously. In that second all weight ceases.

He is in Outer Space.

The only power that can put him there today is the large rocket engine. No matter how far and how fast space travel develops, these high-thrust engines provide one basic essential—the sheer brute force that can lift a payload from the surface of the planet to the airless void outside.

**Endurance for vast distances**

Once space is reached, a wealth of intriguing possibilities beckons. Entirely new aspects of propulsion are being developed to maneuver ships between the moving gravitational fields of Earth's neighbours in the solar system.

PACKHORSE OF SPACE. *Only means to put stores or people out beyond atmosphere is the big, high-thrust rocket.*

One advanced propulsion system that may be built soon is an ion rocket. This ultra-high-specific-impulse power plant provides low thrust for extended periods.

OUTWARD BOUND, *man's robot reporter heads off to a rendezvous with planet Mars.*

An endurance of months, or even years, is possible. Mounted in a suitable unmanned vehicle, such an interplanetary "private eye" would make the cislunar region seem like our own front yard. It could be sent off to reconnoiter the mysteries of Mars, Venus, or the Asteroid Belt.

**Rockets ready today**

To date, the vast bulk of successful missile and space projects in America have used Rocketdyne engines—Atlas and Thor for the Air Force, Jupiter and Redstone for the Army, the historic Explorer satellites, and the all-important first stage of the lunar probes. And Rocketdyne continues to improve the techniques of rocket engineering. High-energy fuels—storability—a full range of proven engine designs: these are some of the contributions Rocketdyne has made to weapon system operation for our nation's defense.

**Million pounds of thrust**

Rocketdyne is now at work on two approaches to propulsion systems that will deliver thrusts up to 1,500,000 pounds. One is a single-chambered engine, the other a grouping of engines adapted from the Thor-Jupiter engine family. From these will stem the multi-million-pound-thrust systems that are essential to launch the manned exploration of interplanetary Space.

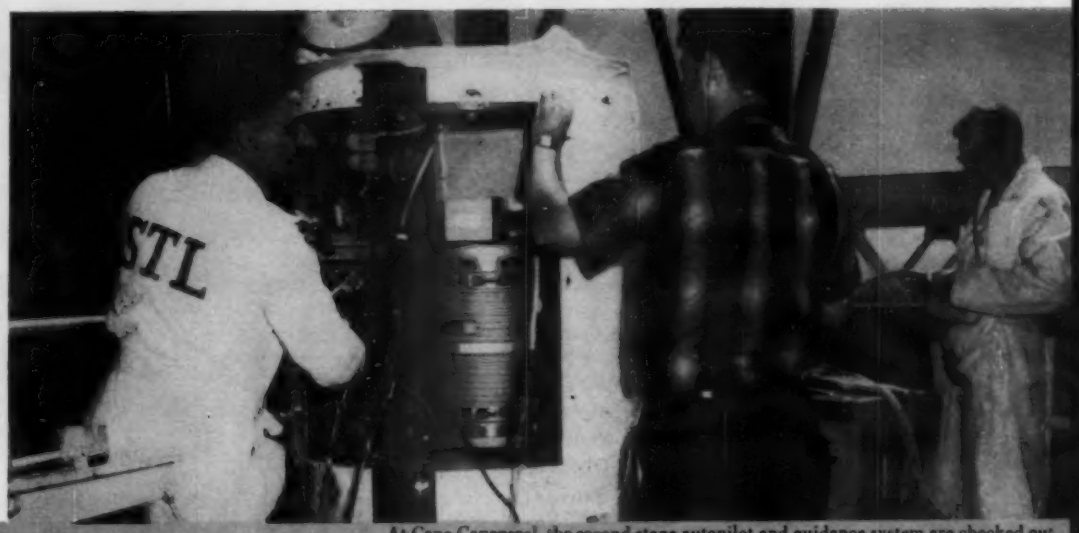
FIRST WITH POWER FOR OUTER SPACE

**ROCKETDYNE**

A Division of North American Aviation, Inc.—Canoga Park, California; Neosho, Missouri

Able test vehicle on the pad at Cape Canaveral.

The Able second stage undergoes final checkout at Space Technology Laboratories.




At Cape Canaveral, the second stage autopilot and guidance system are checked out.

*project*

# ABLE

*an experiment in space!*

**Project Able, carried out by Space Technology Laboratories for the Air Force, has provided scientific data of fundamental importance for successful penetration of the atmosphere from space.**

**The first Able launch occurred April 23, 1958, only four months after the initial design discussions. During those four months STL's Electronics Laboratory designed, fabricated, tested and installed the second stage autopilot, guidance and all electrical and electronic systems, including missile and ground telemetry and checkout equipment.**

**This effort illustrates the contribution of Space Technology Laboratories to specific experimental application, from designing, packaging and testing of hardware, to complete field operations.**

***A number of openings are currently available on our Laboratories' staff for those who can make significant contributions to space flight programs.***

SPACE TECHNOLOGY LABORATORIES

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# EDITORIAL

## Missile Industry Myth Fades

Not long ago there was a concerted effort by people, whose motives are best known to themselves, to promote the myth that ballistic missiles were an "ultimate weapon" that would replace manned vehicles for military purposes in the same manner the automobile has replaced the horse. At the same time they also fabricated the fiction that a new and separate industry, having no roots in the technological past, would spring full-blown to research, develop and produce missiles.

At military levels, this myth quickly dissipated in the face of technical reality. We now have a military program that evaluates realistically the important role of missiles as part of a mixed arsenal. Certainly the intercontinental ballistic missile will play an important role in current and future military planning. But it is by no means an "ultimate weapon". Nor is there ever likely to be any such thing. In addition to the ICBM as an important military weapon, missiles will be used with more mobile launching platforms, (either air or water-borne) than the concrete prairies of a fixed ICBM launching complex. Nor has the concept of a separate missile industry materialized from the events of the past year. As we pointed out more than a year ago (AW Sept. 16, 1957, p. 21), the bulk of the early research and development work on missiles of all types was done by the aviation industry with Convair, North American, Martin and Aerojet-General in the Vanguard.

### Look at the Present

Now let us look at the current situation to see who are the prime contractors on the major missile weapon systems now in advanced development or early production and who has received the major new missile contracts awarded in recent months. Are they new and unknown names in the traditional coterie of aviation industry firms? Or are they the old, familiar names who have been in the aerial vehicle propulsion and guidance business for 30 years or more? In the long range ballistic missile field, there is Convair with Atlas, and Martin with Titan; Douglas with Thor; and, an exception to the rule, Chrysler building the Redstone Arsenal-developed Jupiter. For the Navy, Lockheed is developing the solid-propellant Polaris. Latest Army missile project is the Pershing for which The Martin Co. is prime contractor under a weapon systems management concept. For smaller missiles there is Hughes Aircraft with its Falcon development line, Martin with the Bull-pup and White Lance, North American with Hound Dog, Fairchild with Goose and Gander. In the missile defense area the Douglas Aircraft-Western Electric team for Nike Hercules and Zeus and the Convair-Radio Corporation of America team for Wizard are no strangers to the scene.

The most concerted effort to crash into the missiles business was made by other industries on the USAF Minuteman missile system. Who got the management contract? Boeing Airplane Co., which is also building the Bomarc air defense missiles. Boeing's associated contractors for propellants, guidance and other components are also familiar names in the aviation business.

What is the picture on our efforts to probe the unknown of outer space? The first real military efforts in this line are the Lockheed Sentry reconnaissance project for which research has been done for many years past and the Dyna-Soar project on which the Boeing-Convair and Martin-Bell Aircraft teams are working. The workhorse of long-range space exploration now is the Douglas Thor with an Aerojet-General second stage combined in the Pioneer moon probes. For the immediate future, space efforts will be based on the Convair Atlas and Martin Titan missiles with Pratt & Whitney Aircraft second stages.

In the current competition of the National Aeronautics and Space Administration for space capsules, of the 30 bidders only two are not firms long part of the aviation industry complex.

### No Closed Circuits

Does this mean the missile and space business is a closed circuit with no room for new firms and new technical specialities? Certainly not. The aerial vehicle business that began when the Wright brothers switched their main interest from bicycles to experimental gliding is still in a process of major change. The aviation industry has never been able to rest on its technical laurels and it certainly cannot do it now. As the technical spectrum expands it will require the addition of new firms with new technical specialities and the conversion of current experimental research into the hardware of tomorrow. There is ample room for new faces to fill out the technical spectrum. In a more prosaic field, the expansion of the ground handling equipment and checkout requirement has opened a fertile new field of supplementary business. The current aviation industry must and will expand its technical base to handle the new myriad of problems arising from missiles, space exploration and extremely sophisticated aerial vehicles of all kinds.

It is the aviation industry that has built the research facilities and engineering staffs capable of this advanced development work. But even more important than these vital factors is the ceaseless drive into the unknown that has characterized the people working in the aviation industry from its first days of spruce, wire and doped canvas to the hypersonic speeds of missiles and the long journeys into outer space.

—Robert Hotz

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# WHO'S WHERE

## In the Front Office

**Frederic W. Conant**, vice chairman of the board of Douglas Aircraft Co., Inc., Santa Monica, Calif., has also been named senior vice president-manufacturing; **Arthur E. Raymond** was named senior vice president-engineering. Douglas also named the following vice presidents: **Edward F. Burton**, director of transport aircraft systems engineering; **Edward H. Heinemann**, director of combat aircraft systems engineering; **Elmer P. Wheaton**, director of missiles and space systems engineering; **J. L. Jones**, general manager-Tulsa, Okla., Division; **S. P. Smith**, general manager-Charlotte, N. C., Division.

**Dr. Joel S. Isenberg**, president and technical director, newly organized Flight Sciences Laboratory, Inc., Buffalo, N. Y. Also: **Dr. Kenneth Pearce**, secretary-treasurer.

**George R. Sylvester**, president, Continental Coatings Corp., Cleveland, Ohio.

**Dr. William A. Bain, Jr.**, executive vice president, Vitro Laboratories, a division of Vitro Corporation of America, Silver Spring, Md. **Arthur S. Locke** succeeds Dr. Bain as director of Vitro's West Orange Laboratory; **Dr. Lewis H. Rogers** succeeds Mr. Locke as associate director. Also: **Andrew J. Erickson**, vice president, Vitro Laboratories, and general manager, Vitro Weapons Services, Eglin AFB, Fla.; **Edward W. Clarno**, assistant general manager of Weapons Services at Eglin AFB.

**Capt. Sydney Sherby** (USN, ret.), vice president-engineering and research, Hiller Aircraft Corp., Palo Alto, Calif.

**Hugo Riemer**, executive vice president, United States Borax & Chemical Corp., Los Angeles, Calif.

## Honors and Elections

**William C. House**, director of Aerojet Systems Division, Aerojet-General Corp., Azusa, Calif., has been granted a one year leave of absence to serve with the Advance Research Projects Agency of the Department of Defense, at the request of Roy W. Johnson, ARPA director.

**Air Force's Air Photographic Service** has been awarded the 1958 Airpower Trophy for "The most outstanding contribution to airpower and national security, in the fields of Arts and Letters."

**Mohawk Airlines** has received the National Safety Council's Award of Honor for its outstanding 1957 safety record.

## Changes

**Carey A. Evans**, manager of engineering, Electronics & Instrumentation Division, Baldwin-Lima-Hamilton Corp., Waltham, Mass.

**Samuel W. Chantler**, director of research and development, The Allen Manufacturing Co., Bloomfield, Conn. Also: **Elbert R. Faust**, works manager.

**Searle G. Nevius**, senior electronics engineer, Leach Corp., Compton, Calif.

**A. R. Hunter**, sales manager, Statham Instruments, Inc., Los Angeles, Calif.

*(Continued on page 117)*

# INDUSTRY OBSERVER

► Range of airborne intercept radar being developed by Hughes Aircraft for use on North American F-108 long-range interceptor is expected to be at least six times the range of existing interceptor radars, making the F-108 far less dependent upon ground-based radar for guidance and surveillance. Increased range largely stems from use of new extremely low-noise parametric amplifiers (AW Aug. 4, p. 69; Sept. 1, p. 64).

**► Air Force's new GAR-9 air-to-air missile (see p. 31) being developed for use in the F-108 is expected to have a range three times that of present GAR-1 (Falcon) missile. New GAR-9, which can be outfitted with nuclear warhead, also is expected to be far more maneuverable than present Falcons.**

► Tests of upward ejection seat for Lockheed's F-104 Starfighter, which may replace the aircraft's present downward ejection system, are being conducted on the high speed track at Edwards AFB, Calif.

**► Use of bleed air boundary layer control on the leading edge of the Lockheed F-104 wing is expected to reduce the aircraft's approach and landing speeds by 15-20 kt.**

► In tests of North American Aviation X-15 high-altitude research aircraft, the Boeing B-52 mother plane will be equipped with closed-circuit television to apprise its crew instantaneously of the situation in the research aircraft during the entire time it is being carried to altitude and until the drop.

**► Initial Air Force order for North American T-39 Sabreliner utility transport (AW Nov. 3, p. 34) is for seven aircraft rather than the three originally contemplated. USAF also is considering use of Pratt & Whitney JT12 turbojets, which could be fitted to the Sabreliner with a slight increase in pod size. To combat any such switch, look for General Electric to move to boost the thrust of its J85 turbojet, which now powers the Sabreliner, from 2,500 lb. thrust to near that of the JT12's 2,900 lb. rating.**

► Probability of survival of small and medium aircraft over friendly and enemy portions of a forward battle area is being studied by the Army at its Combat Development Experimentation Center, Ft. Ord, Calif. Study will provide information for developing techniques for reducing the aircraft's vulnerability. Series of similar studies involves CDEC, Ordnance Ballistic Research Laboratory, John Hopkins University's Operations Research Office and the Army Aviation Center.

**► McDonnell F-101, scheduled to replace the Northrop F-89 as Air Defense Command's long-range interceptor, will carry its Douglas Genie MB-1 nuclear-armed air-to-air missile enclosed in the belly rather than on wing pylons as in the F-89.**

► Air Force Thor intermediate range ballistic missile consumers RP-1 fuel at a rate exceeding 55 gal. every second. Main engine appears to be capable of gimbaling about 20 deg. from the vertical centerline for thrust vector control. Vernier engines have even greater gimbaling range.

**► Quick-opening parachute for use by low-flying Army flying platform and VTOL/STOL aircraft personnel is being tested by the Quartermaster Research and Engineering Command, Natick, Mass. Designated the XMP-2, the parachute has a 24 ft. canopy diameter, is designed to open fully in 8/10 sec. Power charge drives a piston that expels 24 steel slugs to extend the shroud lines.**

► During Army evaluation of the Sud Djinn YHO-1DJ two-man helicopter, imported for trials by Republic Aviation Corp., operating cost of the aircraft averaged $6.64 per hr., including fuel and maintenance, during 164 hr. of flight trials. Djinn is in the same class with the two-man Hughes YHO-2U and Brantly helicopters. Army currently has no requirement for this class, but manufacturers hope one will be developed.

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# Washington Roundup

## Holaday: Space Arbiter

William M. Holaday, controversial Defense Department czar of guided missiles whose office has sometimes come under fire for the slowness of decision-making process, has stepped over on White House appointment to head the executive Civilian-Military Liaison Committee. Duty of the committee: to settle disputes arising between the National Aeronautics and Space Administration and the military services over roles and missions in the nation's space program.

Defense Department representatives on the committee are Roy W. Johnson, director of the Advanced Research Projects Agency; Maj. Gen. R. P. Swofford, Air Force assistant deputy chief of air staff (development); Maj. Gen. W. W. Dick, director of special weapons, Army; Vice Admiral R. B. Pirie, deputy chief of naval operations for air. Civilian representatives are Dr. Hugh L. Dryden, deputy director of the National Aeronautics and Space Administration; Dr. Abe Silverstein, NASA director of space development; Dr. Homer J. Stewart, NASA director of program planning and evaluation, and Ira H. Abbott, NASA assistant director for aerodynamics and flight mechanics research.

## Security Virus

Security virus has infected the speech censors in the Pentagon again, leading to public complaints by a number of top military officers in recent weeks. Complaints take the form of off-the-cuff remarks made just before the speaker delivers his prepared text. Texts, of course, have been cleared by the security reviewers. One recent speaker charged that his talk also had been "emasculated." Another, a high ranking Navy officer, told his audience he would attempt to "give you a message within the straitjacket of security in which we operate."

## Prophet Weary

Vice Adm. R. B. Pirie, deputy chief of naval operations for air, let it be known last week that he has become a little weary of missile prophets who insist that the manned aircraft is dead and of their counterparts who believe just as strongly that they must do battle with the missile in order to save the airplane. Speaking at an Aviation Writers Assn. luncheon here, Pirie said:

. . . "In my shop . . . we cover the entire gamut from fleet ballistic missiles to logistic aircraft. I hear sales arguments for missiles and arguments for aircraft. We are now of the opinion these two are not competitors. We believe that missiles must be the agent of destruction in air defense and that the aircraft and ships are the missile platforms.

"Consequently, it is evident that competition is among missiles themselves and among aircraft and among ship platforms."

## Election Notes

Republican membership on the Senate Commerce Committee, with jurisdiction over civil aviation matters, will be substantially changed in the next session of Congress as a result of the elections. Four of the seven Republican committeemen were defeated: Sen. John Bricker (Ohio), Sen. Charles Potter (Mich.), Sen. William Purtell (Conn.), and Sen. Frederick Payne (Me.). Sen. Andrew Schoeppel (Kans.) will step into Bricker's position as ranking minority member. Other significant elections:

• **Jennings Randolph,** until recently director of public relations for Capital Airlines, won a Democratic Senate seat from West Virginia. Randolph specialized on aviation matters during 14 years' service in the House.

• **Sen. Stuart Symington** (D.-Mo.), former Secretary of the Air Force and a member of Senate Armed Services Committee who has led congressional action for a stronger defense effort, was re-elected to a second term.

• **Sen. Henry Jackson** (D.-Wash.), member of the Armed Services Committee and chairman of the Joint Atomic Energy Subcommittee on Military Applications who has teamed with Symington in protesting the Administration's emphasis on economy, also was re-elected.

## Forty Winks for CAB?

American Airlines feels that Trans World Airlines' heavily advertised "sleeper seat service" may have lulled Civil Aeronautics Board members into an unintentional 40 winks. After receiving a complaint by American and United more than a year ago, the Board last June announced plans to ban the service as "unjust" since TWA offered the "sleepers" at first-class fares. American prodded the CAB last week, reminding it that the formal Board order necessary to halt the practice still hasn't been issued. The Board's slowness, American charged, has allowed its competitor to "enjoy the fruits of its violation" for more than a year.

## Retreat From Space

German propulsion expert Dr. Hermann Oberth is returning to Germany after completing a three-year contract as a consultant at Army's Ballistic Missile Agency in Huntsville, Ala. The 64-year-old Dr. Oberth, who believes the most exciting advances within the next 25 years will be concerned with the human brain rather than with space, says he plans to divorce the latter entirely, devoting full time to the study of psychology, extra-sensory perception and related fields.

## Charter Dispute

Civil Aeronautics Board may rescind its Sept. 8 order granting foreign air carriers the right to conduct off-route charters. Strong protests from both U. S. carriers and some foreign airlines forced the Board to postpone the effective date of its order until Dec. 8 to allow time to study the objections raised. U. S. carriers say that foreign governments impose regulations for both on and off-route charters that are much more strict than those applied by the Board. They are urging CAB to guide its awards of off-route charters to foreign carriers by duplicating the rules their governments impose on U. S. airlines.

## Route Survey

Local-service subsidy payments are coming under close scrutiny by the Civil Aeronautics Board which feels the expense involved could be lowered to some extent by weeding out non-productive stops. The Board is investigating 95 small towns now being served by 14 local service airlines on temporary three-year certificates. Board members feel that any stop which has not en-planed an average of five passengers daily during the past year should be dropped. —**Washington staff**

# ARPA Official Hits Space Role Transfers

**Truax defends military space needs, fears U. S. may overstep in assigning projects to NASA.**

By Evert Clark

Washington—Fear that the U.S. may go too far in shifting space projects to civilian control has been voiced by an official of Defense Department's Advanced Research Projects Agency.

Navy Capt. Robert C. Truax, an ARPA military assistant, said some programs "which I and many others in ARPA feel are absolutely necessary to the military exploitation of space may well be transferred in whole or in part" to the civilian National Aeronautics and Space Administration.

The same fear has been expressed privately by members of the three military services and has been hinted at publicly by other ARPA officials. Truax spoke to the Washington chapter of the American Rocket Society.

He proposed a combined ARPA-NASA technical planning and management group to avoid both the transfer of necessary military projects to civilian control and unnecessary duplication, particularly in hardware development. These suggestions, he said, were his own personal observations on how the space program might be handled, and not those of his agency.

It is unimportant which agency carries out a given project, Truax said, "so long as efficient correlation of requirements and programs contribute to their efficient and expeditious implementation." But "perhaps the major hindrance to such correlation is the current attitude of many that space is mostly science and the quicker the military can turn it over to the scientists and forget about it, the better we can all sleep—and sleep we will.

"Space is not an ivory tower to be reserved for the scientists," Truax said. "It is not even primarily scientific in nature if we understand science to mean purely in measurement of environment.

"Space development includes these things but it also includes exploration," Truax said.

"It is the development of means of transportation. It is literally inhabiting a new realm."

### Not Scientific

"The problems to be encountered are not primarily or even largely scientific," he said. "They are problems of engineering. They are in the application of largely known techniques in a somewhat different fashion to get considerably different results.

"We shall make a dangerous and perhaps a fatal mistake if we put the control of space development in the hands of the pure scientist."

Truax said he and many others are certain that the problems of technical planning can be worked out within the present structure but that "our job of moving into space would be easier if NASA and ARPA were to combine their technical planning and program management activities into a single organization under one roof."

This jointly supported Space Development Center would:

- **Take objectives determined separately** by the two agencies and plan the technical approaches for achieving these.
- **Evaluate the "compromises** that would have to be made in adapting single items of equipment to multi-purpose use."
- **Compare technical compromises** "with the dollar savings resulting therefrom and formulate a hardware program."
- **Translate the program,** first, into specifications and then into contracts, placed largely with industry, after both agencies had approved.
- **Administer the contracts** until hardware has been evolved.

Such a center should have no more than 200-300 people if capabilities of the services are used, and should include "the man of vision, the big picture systems man who has a grasp of costs as well as hardware, and specialists in all the fields of technology that contribute to space flight," Truax said.

It also should have "chiefs who are outstanding in their fields and have long experience in, specifically, the rocket, guided missile and other contributing space flight technologies," he said.

There has been criticism that the old National Advisory Committee for Aeronautics, which forms the nucleus of the space agency, had few rocketry and missile specialists, and none familiar with managing major programs, and that the new NASA so far has not brought in such personnel.

Truax said the center also should have:

- **"Sufficient number of 'Indians'** to provide an independent analytical capability. This is essential to permit competing proposals from industry to be evaluated on a comparative basis."
- **Lack of "service or profit bias."** To do so, "it must be adequately staffed with competent people who owe their entire loyalty to the government," Truax said. "They must be sufficiently permanent to ensure that there will be no conflict of interest and that there will be adequate competence and experience in the unique tasks which this organization will have to perform. Salaries must be competitive with industry . . ."

ARPA now employs some of its technical personnel through the Advanced Research Projects Division of the private, non-profit Institute for Defense Analysis. This allows ARPA to hire them from private life, sometimes for

## ARPA Lets Manned Satellite Contract

**Washington—Contracts for development of a manned satellite weighing several thousand pounds and the propulsion stages needed to put it into orbit are being awarded by Defense Department's Advanced Research Projects Agency.**

**In its firmest bid since the establishment of the National Aeronautics and Space Administration to establish the need for a military space agency, ARPA last week announced a contract with Pratt & Whitney Division of United Aircraft Corp. for the development of a liquid-hydrogen-fueled rocket engine to be used as the second stage of the satellite vehicle, NASA also is planning a manned satellite (see page 27).**

**First stage of the manned satellite is scheduled to be an adaptation of the Air Force-Convair Atlas intercontinental ballistic missile. The satellite itself also probably will be built by Convair.**

**The contract, which puts Pratt & Whitney into the space business for the first time, calls for an initial expenditure of approximately $9 million. The ARPA announcement estimated the final development cost at about $23 million. However, actual value of the contract to Pratt & Whitney is expected to be much higher.**

**Work on the second-stage engine will be conducted at both Pratt & Whitney's home plant in East Hartford, Conn., and at its recently completed Florida Research and Development Center (AW June 9, p. 18), headquarters for its experimental work on hydrogen fuels.**

## First Closeup View of Soviet Tu-16

First closeup view of the Soviet Tupolev Tu-16 medium twin-jet bomber, designated Badger by NATO (AW April 16, 1956, p. 47), shows configuration of radome which houses bombing and navigation radar. Note air intake for 19,500 lb. thrust turbojet engine.

limited periods, and at salaries more comparable to industry pay than what they could receive in civil service positions.

• "**Clearly defined authority** as well as responsibility."

If the "thousands of details of technical coordination" were handled by such a center, the National Aeronautics and Space Council chaired by President Eisenhower then could devote its attention "to such major policy questions as the over-all funding level of the space effort and the proper apportionment of funds between civilian, military and common efforts; the domestic and foreign political aspects of our space program and other such matters as they are properly qualified to handle."

Truax said he believes "some of our actions in the past year have been somewhat frantic and not too well considered," but three steps would "set us on the right track:"

• **Create an integrated organization** such as the development center.

• "**We must realize that the conquest** of space is primarily an engineering problem to achieve a military objective, not—perhaps unfortunately—a scientific problem to achieve a humanitarian objective."

• "**Devote a major effort to** large and more efficient space vehicles." Truax advocated doing this on a building-block basis, with few standardized vehicles rather than "a large stable of special purpose vehicles."

• "**Reach an adequate level** of financing and sustain this level until we are definitely the world leaders in space.

*Space Technology*

# NASA Capsule Bidders' Meet Attended by 30 Aviation Firms

**Washington**—Representatives of 30 aviation firms were scheduled to attend a bidders' conference held by the National Aeronautics and Space Administration late last week in a first step toward the long-range development of manned U.S. satellite capsules.

The conference, held at Langley Research Center, Langley Field, Va. (AW Nov. 3, p. 33), also marked one of the initial steps NASA has taken on its own since its formal establishment on Oct. 1.

### Cost Near $30 Million

Industry proposals on the capsule project are due by Dec. 4. Before its budget requests were cut in Congress by $50 million, NASA had estimated that over-all cost of the capsule development program would approach $30 million (AW Aug. 11, p. 20).

Program at that time included eight test capsules at $4.8 million and four test capsule subsystems at $3 million. Five Thor-Able missiles or the equivalent would be used for instrumented and small-animal flights at a cost of $8.4 million.

Two Convair Atlas or equivalent vehicles would be used for two full-scale capsule test flights at a cost of $5.3 million.

Contractors scheduled to attend last week's meeting were:

Fairchild Engine and Airplane Corp., General Electric Co., Goodyear Aircraft Corp., Grumman Aircraft Engineering Corp., Lockheed Aircraft Corp., The Martin Co., McDonnell Aircraft Corp., North American Aviation, Northrop Aircraft, Thompson Ramo Wooldridge, Republic Aviation Corp., Ryan Aeronautical Co., Lear Inc., Allison Division of General Motors, Sperry Gyroscope Co., Westinghouse Electric Corp., Aerojet-General, All-American Engineering Co., United Aircraft Corp., Winzen Laboratories, Aeronutronic Systems Inc.

Aerophysics Development Corp., American Machine & Foundry Co., Avco Manufacturing Corp., Bell Aircraft Corp., Boeing Airplane Co., Chance Vought Aircraft, Convair Division of General Dynamics Corp., Cook Research Laboratory and Douglas Aircraft Co.

During congressional testimony earlier this year, officials of the National Advisory Committee for Aeronautics, NASA predecessor, said an Atlas-powered manned capsule could be sent into orbit at about 120 naut. mi. Full-scale mockup of an NACA capsule al-

ready has undergone some ground tests, including all-axis motion simulation at Langley.

Capsule, as then envisioned by NACA, could be cone-shaped, 7 ft. in diameter at the base, weigh approximately 2,200 lb. and employ retro-rockets deployed laterally and firing through a central nozzle and attitude jets. The crewman would recline on a couch at the base of the cone. First flights of a manned capsule would call for only a few passes around the earth. At 25,000 ft. and low subsonic speeds, a large parachute would be deployed for re-entry. Deceleration would be 10G.

# Subsonic Missile-Platform Aircraft May Play Important Navy Role

**Washington**—Grumman A2F-1 attack plane now under development may be the forerunner of a series of subsonic navy "Missileer" missile platform aircraft for use in both interceptor and attack roles.

"Missileer," new name for the earlier, and much-debated, "slow plane" concept, envisions use of a subsonic aircraft carrying highspeed, long-range air-to-surface missiles as an attack plane, long-range air-to-air missiles as an interceptor.

The Soviet Union apparently already has partially turned to the "slow plane" concept in the development of interceptor aircraft, a role which appears to hold more promise for such a plane than the attack mission.

All-weather models of the Yak Flashlight interceptor carry radar large enough to fire missiles on long-range intercept missions at distances of up to approximately 50 mi. The Soviets also are developing a 75-mi.-range air-to-air interceptor missile (AW Sept. 8, p. 23) that operates as a beam rider until it reaches the vicinity of its target. An internal homing device apparently takes over to guide the missile on its final run to the target.

The A2F-1, for which Grumman received a development contract in January (AW Jan. 6, p. 34), will be designed to hold a speed of approximately Mach .9 at sea level. As an attack plane, it will fire its air-to-surface missiles, probably the Temco Corvus, about 75 mi. from the target. Powerplants are two 7,500 lb. thrust Pratt & Whitney J52 engines.

Navy hopes that the A2F, by flying as close to ground level as possible, can escape radar detection until it has had a chance to fire its missiles and that its Mach .9 sea level speed will provide adequate protection against a high-speed interceptor whose performance is relatively poor at low altitudes.

The two-place A2F, carrying a pilot and radar operator, also may be used as a carrier-based interceptor when equipped with Eagle air-to-air missiles (AW Sept. 29, p. 15). Eagle will have a range of 30-mi.-plus.

Bidders in the Eagle competition have included Chance Vought, General Electric, United Aircraft, North American Aviation and Douglas Aircraft plus two team proposals—Convair, Sperry Rand and Radio Corp. of America on the one hand, Bendix and Grumman on the other.

As an interceptor, the A2F would operate at substantially higher altitudes, probably gaining some increase in speed.

The aircraft will be equipped with an inertial guidance system under development by Litton Industries. The system employs an extremely small, lightweight, stabilized platform using two-degree of freedom floated gyros.

Inertial guidance systems, which will be employed in most of Navy's first-line combat aircraft in the future, have the advantage of being self-contained and require no electromagnetic radiation from ship, shore or other aircraft that could reveal the presence of the aircraft or could be jammed by enemy countermeasures.

Intended primarily for carrier operations, the A2F also is being designed to incorporate a short-field capability for use from land bases when necessary.

In formally announcing the decision to let a contract for the A2F, Vice Adm. R. B. Pirie, deputy chief of naval operations for air, last week explained much of Navy's philosophy behind the "Missileer" interceptor concept. Speaking at an Aviation Writers Assn. meeting here, Adm. Pirie said:

"The present combination of fast fighters carrying short-range missiles comprises the airborne portion of our task force defense against air attack. Intercepts must be made at relatively short range with little time available.

"With missile and radar development what it is, why must we bore supersonic holes in the air for air defense? A follow-on fighter concept is the answer. This concept exploits sophisticated long-range detection devices. It depends more and more on the high Mach speed ability of missiles to make the kill of attacking bombers."

Adm. Pirie said other military services also are studying the concept.

A true "Missileer" aircraft, Pirie said, "would be a virtual heavy cruiser of the air. It could track more than one target and control more than one missile at a time. It could stand off the enemy from many directions with its missiles."

## Eagle in Doubt

**Washington — Defense Department fiscal planners are again pressuring Navy to abandon its competition for development of the Eagle long-range air-to-air missile in favor of the Air Force-Hughes GAR-9 scheduled for use on the North American F-108 interceptor.**

**Late last summer, Defense had urged Navy to abandon the Eagle for economy reasons and adopt the GAR-9, which is futher along the development cycle (AW Sept. 15, p. 23). Later, it bowed to Navy arguments that the Hughes' missile would not fit into the Eagle's intended mission (AW Sept. 29, p. 15).**

**Now however, Defense planners, faced with a tight Fiscal 1960 budget, are once again pushing Navy to accept the GAR-9.**

**Despite the pressure, Navy still hopes to retain the Eagle. Final decision on the contract had been scheduled for Nov. 15, with the team proposals of Grumman-Bendix and Convair-Sperry Rand-Radio Corp. of American apparently in the lead for the award.**

## SHAPE to Increase Missile Capability

**Paris**—Current SHAPE planning calls for reduction of about 30 to 40 air squadrons in the NATO shield force and a corresponding increase in rocket and missile capability for NATO ground forces.

These goals are part of the current SHAPE planning program which deals with NATO requirements through 1963. They were commented on in Paris by SHAPE Supreme Commander Gen. Lauris Norstad.

Norstad said that by 1963, NATO ground forces will include more than 100 rocket and missile battalions instead of the present 30. He did not elaborate on the type of rockets and missiles involved, although he did say stress would be put on those having battlefield characteristics.

Norstad also said this switch into rockets and missiles meant that the present heavy NATO reliance on airpower for its holding mission would be eased by 1963, thus permitting reduction in NATO air forces.

The general refused to admit to undue SHAPE concern over the fact that a large part of the NATO air force—composed of some 5,000 aircraft—would be obsolete by 1960. The SHAPE commander said that this problem was a continuing one and that

SHAPE planning called for introduction of newer types of aircraft as they became available. Norstad did not spell out details except to mention a lightweight fighter as one example of the SHAPE modernization program.

Other major points are:

• **Lightweight fighter:** Norstad said some 10 to 12 Fiat G.91 fighters are currently undergoing tactical tests at an air field near Rome. He said the test group hoped to move into Germany soon where an experimental squadron will train with a brigade or division of Allied Land Forces, Central Europe. The squadron, Norstad indicated, will have pilots and ground crews of France, Germany, Italy and Turkey.

Norstad said several NATO nations had indicated intention to order the Fiat aircraft despite the fact that no orders have yet been placed. Future lightweight fighter program, Norstad said, would depend on outcome of the current tests. He also said that if NATO goes into a second generation lightweight fighter—which under NATO agreement last January was to be the French Breguet Taon—this generation would be considerably different from the previous generation. Aircraft he thought would either be vertical takeoff and land type or capable of takeoff within 200-300 ft.

## B-70 Will Navigate In All Weather

**Los Angeles**—Bombing and navigation system being developed for North American Aviation's B-70 bomber by the Military Products Division of International Business Machines Corp. will allow the B-70 crew to continuously correct the plane's course from takeoff to target.

System will utilize a stellar-inertial platform built by North American's Autonetics Division. The stellar segment of the subsystem uses stars as navigational reference points and the inertial segment uses gyros and other devices to determine the aircraft's speed and geographical position.

Integration of stellar-inertial and radar subsystems with IBM's digital computer will allow the B-70 to navigate under all-weather conditions. IBM's digital computer will control and coordinate all parts of the bombing navigation system, processing data received from the search and Doppler radars and the stellar-inertial platform.

The B-70's console combines a simplified navigator's instrument panel with radarscope and keyboard. Radarscope will provide visual display of terrain. Flight data such as present position, speed, altitude and destination time-to-go can be requested from computer by operator for display on lighted panel.

## Marquardt Acquiring Cooper As Subsidiary

**Los Angeles**—Negotiations have been completed by Marquardt Aircraft Co. for acquisition of Cooper Development Corp. in exchange for 60,000 shares of Marquardt capital stock. Cooper, developer and manufacturer of support equipment for aircraft and space research programs, will be operated as a wholly owned Marquardt subsidiary, retaining its present staff.

## Encapsulated Liquid Fuel Study Initiated

**Los Angeles**—Research in encapsulation of liquid fuels has been initiated at National Cash Register Co.'s Dayton, Ohio, facilities under two military contracts. Polymer-type materials are being used to enclose liquid fuel in microscopic capsules to impart stability, longevity and easy handling characteristics of solid fuel formulations.

Program may lead to the ability to handle hazardous and unstable fuels which also are normally highly reactive with metals. Perfection of an encapsulation material and configuration may lead to a technique for controlling burning rate, with maximization of liquid fuel volume through control of capsule film thickness. Estimates are that encapsulation materials may be developed which would allow fuel volume to reach 95% of total storage volume available in rockets.

Conventional jet fuels already have been encapsulated at National Cash Register's Dayton facility merely to establish the technical feasibility of the encapsulation process. Future research will be directed toward encapsulation of liquid fuels with higher specific impulses.

The encapsulated formulation may be caked to represent a solid fuel formulation or may be rendered free-flowing to pass through a two-micron orifice, according to a spokesman.

## Northrop Profits Up, Snark Sales Low

**New York**—Orders for the Northrop SM-62 Snark cruise missile were disappointingly low for Northrop Aircraft, Inc., in its fiscal year which ended July 31, but increases in volume of its avionics business and in its over-all profit margin were offsetting factors.

Company sales declined from $281,200,824 the previous year to $256,284,554 in the latest fiscal year but earnings rose from $5,522,595 or $3.62 a share to $6,796,285 or $4.29 a share. This is an increase in Northrop's profit margin from figures of 1.9 to 2.6%.

Current Air Force contracts for the T-38 supersonic trainer—which call for two prototypes, one static test model and four for service testing—have not reached the point where they would contribute substantially to sales. Follow-on contracts for 13 more aircraft are being negotiated.

Northrop's Nortronics Division, which specializes in electronics, contributed $55 million in sales during its first year of operation.

Because of its changing character, Northrop will ask shareholders this year to change the company name to Northrop Corp.

Among this division's developmental projects for the National Aeronautics and Space Administration is a device called Q-Ball, an attitude sensing system to assist high performance aircraft or ballistics to establish the correct attitude for atmospheric re-entry.

In other financial reports:

• **Vertol Aircraft Co.** sales continued to decline during the third quarter, but a cost reduction program enabled the company to increase earnings compared with the previous quarter.

Third quarter earnings were $160,690 or 26 cents a share on sales of $8,587,554 compared with second quarter earnings of $22,386 or 4 cents a share on sales of $10,693,972. Last year, third quarter sales were $17,918,483, with earnings of $284,811 or 45 cents a share.

Nine month totals were sales of $29,668,815 and earnings of $345,711, or 56 cents a share, compared with figures last year of $59,871,285 for sales and $1,606,890, or $2.96 a share for earnings.

• **Martin Co.** in filing a prospectus with the Securities and Exchange Commission for a $20 million sinking fund debenture offering, reported an increase in earnings for the first nine months. On sales of $356,037,000 compared with $317,503,000 a year earlier, earnings were $3,713,049 compared with $2,077,117 a year earlier.

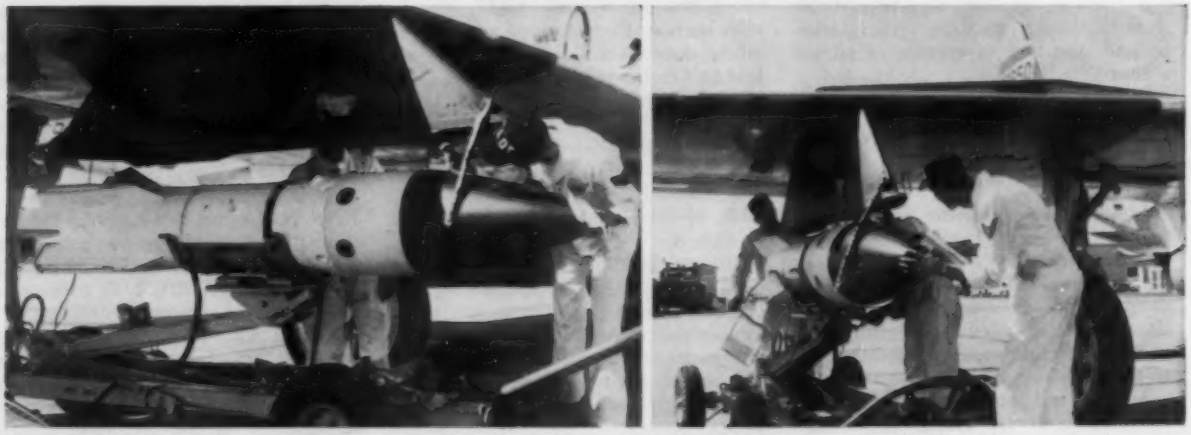
The debentures will carry warrants for the purchase of 200,000 shares of capital stock in 10 share units. Neither the stock price per 10 share unit nor the debenture interest rate was specified.

Martin had planned to offer a debenture issue with no stock purchase privileges last July (AW July 7, p. 54), but withdrew it, reportedly balking at an interest rate over 5%.

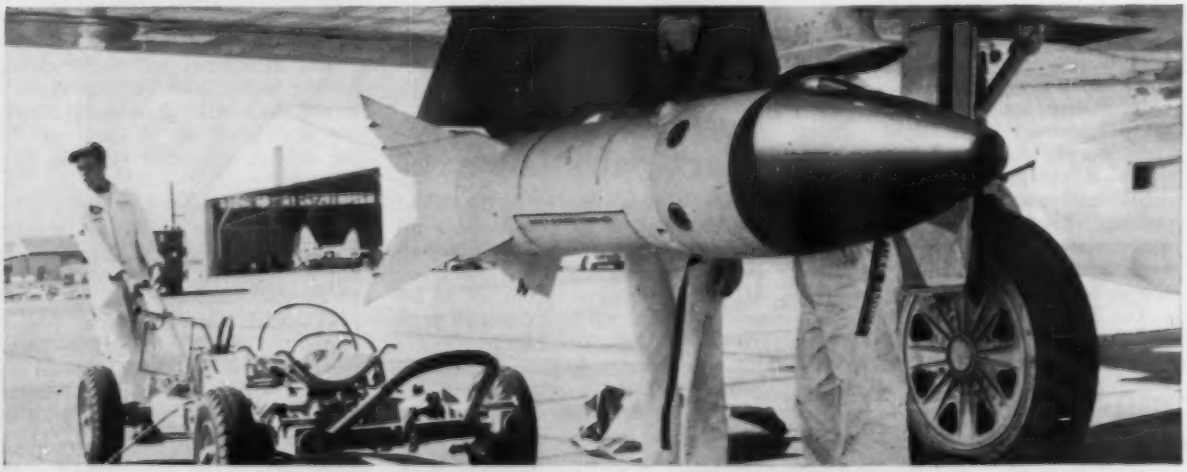
Financial sources in New York reported the issue would carry an interest rate of 5¼-5½% and that the initial price for the stock with warrants—effective until Nov. 1, 1963 when the price will increase—will be $40 a share. Martin stock was selling last week at $35¼-$35½ a share.

Unarmed MA-1 training version of Genie MB-1 nuclear-warhead aerial rocket shown on cart at Tyndall AFB, Fla., during USAF gunnery meet (AW Nov. 3, p. 28). Instant of warhead detonation is pre-set by Hughes Aircraft Co. fire control system before launching.

# First Detailed Closeup of Genie Ground Handling



Air Defense Command Northrop F-89Js are equipped to carry Douglas Genies in each of two external pylons slung under the wings.



Lethal radius of Genie is at least 500 to 1,000 ft., based on scoring in meet when missile was fired against Ryan Q-2A jet drones.

# New Technology Boosts Interceptor Role

By Philip J. Klass

**Tyndall AFB, Fla.**—New airborne radar with greatly increased operating range and new long-range, highly maneuverable air-to-air missiles capable of hitting targets at any altitude may give the manned interceptor a significant advantage over unmanned surface-to-air interceptor missiles against enemy bombers in many tactical situations.

This opinion, expressed by Allen E. Puckett, associate director of Hughes Aircraft's Systems Development Laboratories, during the interceptor phase of Air Force's recent World Wide Weapons Meet here, is significant because Hughes is developing both the new nuclear-warhead GAR-9 air-to-air missile and the airborne radar and fire control system for North American's new Mach 3 F-108 manned interceptor.

Puckett called for a balanced strategy and cautioned against becoming preoccupied with the threat of enemy ballistic missiles and ignoring the threat of enemy manned bombers. "We cannot assume that a war will be fought in any one way and concentrate our attention in preparing for that one way," Puckett said. "This will simply ensure that the enemy will find another strategy which is much more profitable."

### Missile Defense

On the subject of defenses against ballistic missiles, Puckett said it should be feasible to devise a system that "could intercept one or two incoming ballistic missiles, in a demonstration fashion, with approximate arrival time (of missiles) previously announced and characteristics reasonably known."

"The real problem," Puckett pointed out, "is quite different. The unsolved question is whether it is economically feasible to build a system sufficiently extensive to yield any useful level of defense against a much larger and less well defined attack, including circumstances in which it may be difficult to distinguish real targets from false ones."

Current trend to missiles and talk of push-button warfare tends to obscure the fact that humans are required to exercise judgment and control, at least to some degree, Puckett pointed out. "The interesting technical question is where should the man be located in order to exercise most effective control and what should this control be," he said.

If a weapon system is designed for minimum human judgment and control and maximum automaticity, many tactical decisions must be made in advance. Success of the system then depends upon "our ability to accurately predict the particular pattern of action the enemy will employ," he said.

The effectiveness of the human operator in making effective decisions and taking correct action, regardless of whether he sits on the ground or in the air, depends upon the extent to which he knows what is taking place in the battle.

If the man is in an interceptor, he is better able to identify the enemy and establish the nature of his force, the type of attack that may be most effective, and something of the enemy tactics and countermeasures, Puckett said. For long-range interception, man is able to exercise control over the attack on enemy forces far earlier than is possible if human intelligence is exercised only on the ground near targets that are to be defended, Puckett said.

### Advanced Radar

Major advance in performance of the next generation of interceptor radars, which will extend the range "many times" over current systems, will largely free the interceptor pilot from current dependence upon ground radar or early warning aircraft and provide considerably more time for human battle decisions, Puckett predicted.

Vastly superior speed and range of new interceptors such as the F-108, will make it possible to engage the attacking force far more quickly, at greater distances from target areas. The F-108 will have an operational radius of at least 1,000 mi., according to a North American spokesman.

### Future Missiles

New air-to-air missiles, with far greater range and far more maneuverability than present weapons, will greatly reduce the accuracy with which the human pilot must position his interceptor for a successful attack. Next generation air-to-air missiles, such as the GAR-9, will be capable of attacking bombers far below and far above the interceptor.

This will leave the pilot relatively free to continue his surveillance of the air battle and to exercise his judgment concerning future action, according to Puckett.

Significant advantage of manned interceptor, Puckett said, will be its flexibility and the possibility of using it in situations which we cannot now visualize, from bases or in battle areas quite remote from those now prominent in our defense thinking.

## New Hope For CF-105?

**Washington**—Canadian aircraft industry is making an all-out fight to save the Avro CF-105 Arrow and to keep alive Canada's capacity for the original design of high performance aircraft.

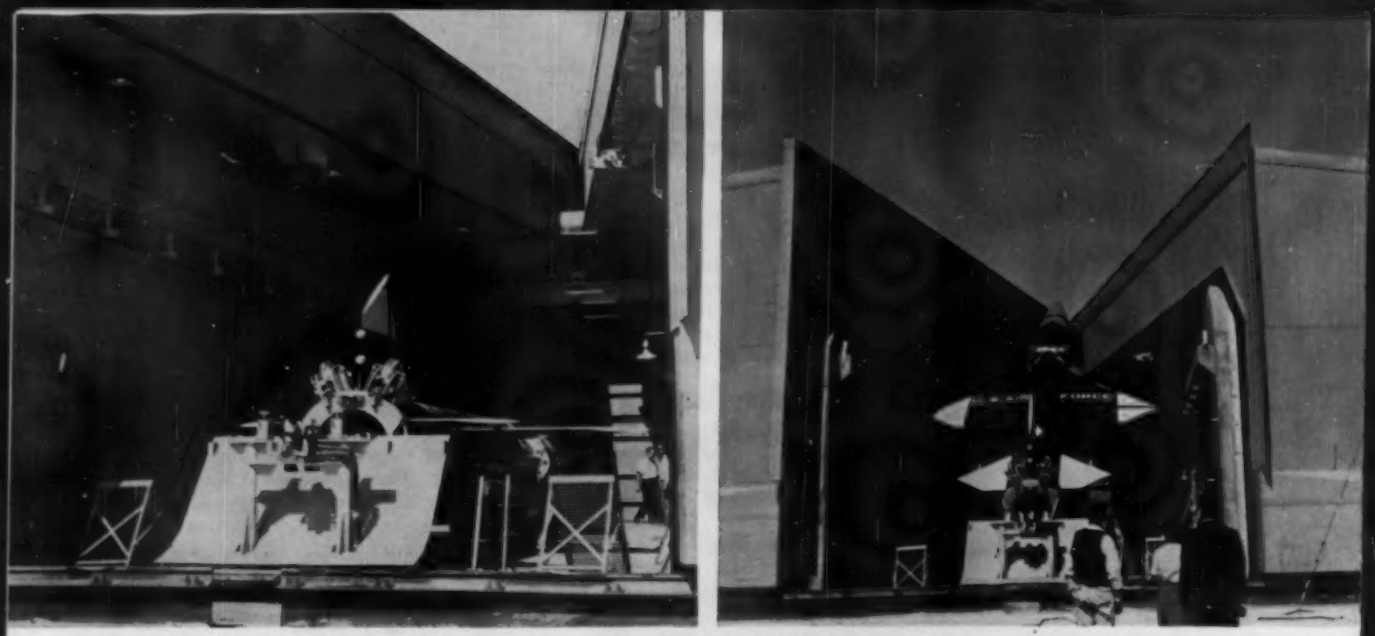
Three factors have raised considerable hope that the Arrow will be produced in quantity and that the Conservative government of Prime Minister John Diefenbaker will reverse its apparent plan to switch completely to missiles for Canadian air defense (AW Sept. 29, p. 22). They are:

- Arrow is bettering its performance predictions and has exceeded 1,500 mph. powered by the Pratt & Whitney J75. Estimates are that the Orenda Iroquois turbojet, which delivers more thrust and weighs less than the J75, will give the Arrow a top speed of better than 2,000 mph., or in excess of Mach 3 at 40,000 ft. and above.
- Avro has revised its cost estimates for the Arrow in light of the replacement of the RCA Astra navigation fire control system, which is in development, with a production system made by Hughes Aircraft. The new price is $3.5 million per aircraft for a lot of 100 Arrows. The price last summer was $9.6 million per aircraft for a similar quantity.
- All segments of Canada's aircraft industry are reported to be applying maximum political and technical pressure to save the Arrow and Iroquois. The political pressure is directed at Ottawa, and the technical effort is being made to deliver all necessary equipment and accessories in time to meet the December date which has been set for the first flight of the Iroquois-powered Arrow.

Canadian hopes center around avoiding early trouble with the Iroquois and achieving the Mach 3 speed relatively soon. The Arrow program is scheduled for a formal re-evaluation by the Canadian government in March.

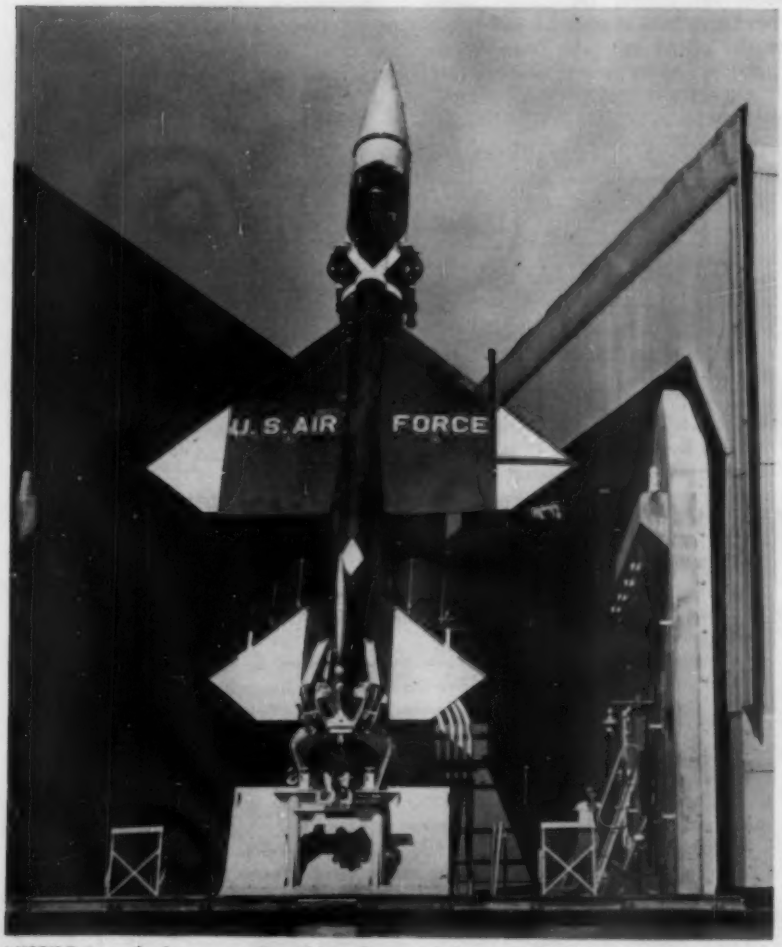
Speculation is that it will be difficult for foreign governments as well as that of Canada to turn down a Mach 3 aircraft that is flying in early 1959. This would be two or three years before other Mach 3 aircraft now in development and would give Canadian industry an achievement that could not be ignored.

Prime Minister Diefenbaker announced earlier that Canada would buy the Boeing Bomarc missile and establish two bases from which to operate them.



**BOMARC** clamshell hangar is one of three hangar types under evaluation at the first Bomarc interceptor missile operational launch site on Santa Rosa Island, Fla. Hangar swings open in seconds, permitting the missile to be quickly erected and launched by remote control.

# First Bomarc Site Nears Completion




**MISSILE** is ready for remote launching. Improved Bomarc IM-99B will be tested at the Santa Rosa Island site. Crews also will be trained here for assignment to other Bomarc sites.

**Santa Rosa Island, Fla.**—First Air Force Bomarc (IM-99A) interceptor missile to be fired from a site other than the Cape Canaveral, Fla., test center is scheduled to be launched on Dec. 4 from a new Air Defense Command center nearing completion here.

The $25 million site near Eglin AFB will be used for evaluation of the new 400-mi. range Bomarc-B (IM-99B) as well as for initial training and periodic evaluation of crews that will man the regular Bomarc sites.

Bomarc launched from Santa Rosa will fly over the Gulf of Mexico range under control of the SAGE air defense sector center at Montgomery, Ala., or of a semi-automatic AN/GPA-37 intercept computer at Eglin (AW Aug. 18, p. 58). Missile will be tracked by existing air defense radars located along Florida's Gulf Coast and guided by means of data link to the vicinity of the target where Bomarc's own radar will take over.

Center is operated by the 4751st Air Defense Wing (Missile), commanded by Col. Joseph Myers, under the 73rd Air Division (Weapons) located at nearby Tyndall AFB.

Three different types of Bomarc launch stations are being constructed at Santa Rosa for comparative evaluation. In one type, the entire enclosure splits down the center and opens like a clamshell. In the other two types, both of less expensive construction, only the roofs open to permit missile firing.

Each launch station houses a single Bomarc mounted on a hydraulically operated launcher that can be elevated from horizontal position to required elevation angle in a matter of seconds

upon command from the remote SAGE center.

Critical circuits in the missile are continuously and automatically checked on a 24-hr. basis to assure that Bomarc is in a continuous state of readiness, according to an Air Force spokesman. The missile will be given a complete operational check-out on its launcher every 30 days, pulled out and returned to Hurlburt Field for full inspection and test every six months, according to present plans. Facilities at Hurlburt enable missile to be subjected to simulated shock and loading conditions.

Boeing is setting up an experimental hangar at Hurlburt to support initial flight tests on Bomarc-B slated to begin early next year. Range of the new version will be more than 400 mi., better than twice the range of IM-99A. New version will use solid-propellant booster rocket instead of present liquid fuel, a change that is expected to greatly simplify ground handling and launching procedures. New version will continue to use two underslung Marquardt ramjet engines, but improved performance is expected to boost the Bomarc-B speed above the present Mach 2.6 figure.

Bomarc can be armed with conventional or nuclear warhead. Missile uses airborne radar developed by Westinghouse Air Arm Division for terminal guidance once the missile has been guided to vicinity of target by ground stations.

# Nike-Zeus May Be Inadequate, Top Defense Scientist Warns

**Atlanta, Ga.**—Nike-Zeus ballistic missile defense system cannot provide effective, adequate defense against multiple ballistic missile threats, decoys and radar jammers without requiring more anti-missile missiles and nuclear warheads than the U. S. can afford to spend, according to a top Advanced Research Projects Agency scientist.

Dr. Richard Holbrook, scientist in ARPA's ballistic missile defense group, Institute of Defense Analysis, says many new techniques, ideas and concepts are needed to devise an effective ballistic missile defense system.

ARPA plans to spend $100 million this year in investigating such new techniques, would need to spend $400 million to fund all the proposals it has received, Dr. Holbrook said in talk at the Atlanta chapter of Sigma Delta Chi, honorary journalistic fraternity.

Dr. Holbrook cited the following as examples of the difficult problems that must be solved before the nation can develop an effective defense against ballistic missiles:

• **Decoys:** Metal-coated rubber balloon weighing only a few ounces can be shaped to look like a nose cone warhead to a conventional type radar unit.

• **Jammers:** Small, low-power transmitters released by a ballistic missile nose-cone can effectively jam or blot out defense radars.

• **Multiple warheads:** Instead of single warhead, nose cone may release a number of smaller nuclear warheads. This would require defense system to knock down each of the smaller warheads. If conventional defense techniques are used, it would require more missiles and warheads "than we can afford to expend," Dr. Holbrook said.

"We need to know a great deal more than we do now about a great many complicated and difficult things before we will be ready to devise a much better defense system," Dr. Holbrook said, and this is an objective of ARPA's program. Examples cited include:

• **Re-entry physics:** How do different kinds of bodies behave upon re-entry?

• **Kill mechanisms:** More knowledge is needed on the lethal effects of nuclear weapons in the upper atmosphere.

• **New detection techniques:** More investigations are needed to determine effectiveness of other detection techniques, such as infrared, low-frequency radio waves.

The list of unknowns is a very long one, Dr. Holbrook said, and filled with critical questions whose answers can only be obtained by a coordinated research program.

Scientists are trying to obtain some of the answers by observing our own ballistic missiles during launch, mid-course flight and re-entry, using a variety of radars, infrared, optical devices and radio type receivers, Dr. Holbrook said. "Everything is interesting, and everything costs money. To do everything down-range which might be worthwhile would cost more money than we have this year for the whole program."

ARPA has organized a panel of professional people to consider, evaluate and recommend which of the down-range investigations should be given highest priority. Similar groups assign priorities to projects in other areas.

## German Decision

**Geneva—German Defense Committee last week recommended choice of the Lockheed F-104 Starfighter for future interceptor, recommended the purchase of 50 Fiat G-91 lightweight fighters, and production of additional 150 under license and purchase of 60 Sud Aviation Alouette helicopters as light transports.**

**Presumably this is the final and firm decision but details of contractual agreements remain to be worked out (AW Nov. 3, p. 26).**

## Cessna May Merge With Aircraft Radio

Directors of Cessna Aircraft Co. and Aircraft Radio Corp. have agreed to merge the two companies pending approval of stockholders. Agreement basically calls for Cessna to exchange two shares of its stock for three of ARC's—the latter has approximately 312,000 shares outstanding, thus some 208,000 shares of Cessna would be involved in the transaction.

Stock swap would not take place at least until after Cessna makes payment of a recently voted 10% stock dividend, issued in addition to its regular 40 cents per share cash dividend. Extra stock will be issued Dec. 15 to holders of record Nov. 19; the cash dividend will be paid Nov. 17 to holders of record on Nov. 3. Aircraft Radio will be operated as a division of Cessna.

Aircraft Radio's sales for Fiscal 1958 will be approximately $12 million, compared with some $10 million in 1957. Approximately 40% of its business is commercial equipment for business and airline aircraft. When new expansion is completed it will have approximately 164,000 sq. ft. of engineering and production area at its Boonton, N. J., location that currently employs some 750.

Estimated Cessna sales for Fiscal 1958 are $86 million, a 23% gain over 1957, with commercial aircraft sales increasing $5.6 million over last year's total of $32,628,478 and military business being up from $32,476,276 in 1957 to approximately $41.9 million for Fiscal 1958. Sales from hydraulic equipment by its industrial products division were approximately $5,880,000 compared with $4,830,000 in 1957.

## Pre-Packaged Liquid Rocket

**Reaction Motors Division of Thiokol Chemical Corp. has developed and successfully fired a pre-packaged liquid propellant rocket engine of 50,000 lb. thrust. Currently, the company has Navy contracts for the production of Guardian I and development of Guardian II engines, small pre-packaged liquid propellant powerplants of only 8,000 and 10,000 lb. thrust respectively. Successful firing of the large engine is considered a major development which opens the door, theoretically, to pre-packaged powerplants of unlimited size.**

# Navy Warfare Simulator Trains Officers

By James A. Fusca

**UMPIRE AREA** of the Navy Electronic Warfare Simulator groups problem director and umpires around 15 ft. Plexiglas master plot screen which provides a composite picture of the maneuvers and interactions of the simulated forces to assist in observation and evaluation of the problem in progress. Weapon-target status displays for each of the opposing sides are to the left and right of the screen. Equipment consoles on the main floor are: communication console, problem control intercom, plot control console, and simulated radar repeaters.

**TYPICAL COMMAND CENTER,** one of 20 used as part of the Navy Electronic Warfare Simulator, simulate a flag plot, unit command combat information center, air command center or command tactical center of any or all assigned forces on a side in which the commander observes and evaluates the battle situation and exercises command. Facilities include simulated radar repeaters, fire control panel, force motion control panel, target information panel, problem control panel, status board, vertical plot, dead reckoning table, teletype and radio telephone.

**Newport, R. I.**—Officer students attending the Naval War College here are being trained to make the complex command decisions of modern nuclear warfare by means of a highly realistic Navy Electronic Warfare Simulator that went into operation last week.

The object of the simulator is to provide a two-sided war game using electro-mechanical techniques to obtain the elements of mobility, fire power and intelligence on which opposing commanders may exercise their skill and judgment in employing their assigned forces in real time.

The simulator has been under development since 1945; the cost is estimated to be about $7.5 million. It occupies a building a block long and three stories high. In addition to rooms housing a combination analog-digital computer and related electronic equipment, the installation consists of 20 Command Centers and an amphitheater for umpires and spectators.

Each commander, his staff, and individual unit commanders are located in the 10 command centers provided for each side. The command centers realistically simulate a flag plot, unit command center, or an air tactical command center. From his flag plot, a commander observes and evaluates the battle situation as it develops, exercises control of his assigned forces, and tests the soundness of his battle plan.

The umpires, each an officer with professional experience in the type of operation he umpires, are located in the Umpire Area, an auditorium-type of room which includes the equipment to enable the problem director and umpires to observe and evaluate the operation. Optical projectors project images of each simulated force on a 15 ft. master plot screen which provides a composite picture of the forces, their maneuvers and interactions.

The results of these interactions as the war game progresses are determined by the umpires, assisted by a combination analog-digital computer which stores weapon characteristics and target damage data. The computer determines hit probability, based on weapon characteristics and range to target, and computes incremental damage per hit based on target vulnerability to the weapon being used.

Based on these solutions, the computer computes interaction damage and automatically introduces a reduction of maximum speed and weapon effectiveness of the target force when appropriate. A decision by an umpire may be inserted manually to eliminate, add or

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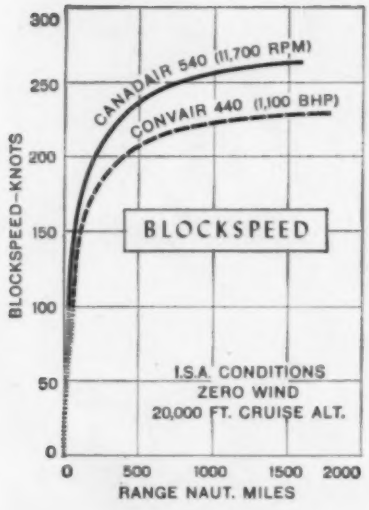
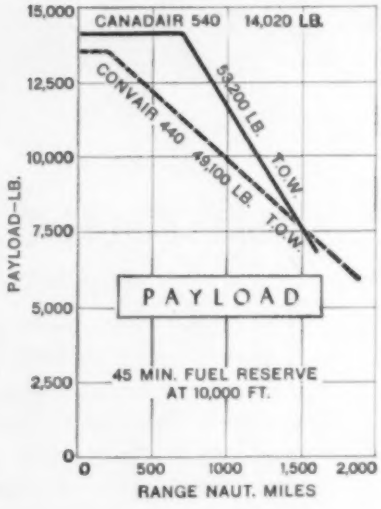



**Graph at left** shows the significant improvement in speed available in the turbine-powered "540" compared with the "440"—as much as 34 knots at a range of 1000 nautical miles.

**Graph at right** shows that the earning potential of the "540" is greatly increased. It is capable of carrying 48 passengers, plus their baggage, plus 4210 lbs. of cargo (total payload: 14,020 lbs.) a distance of 680 nautical miles. This represents a payload increase of 365 lbs. over the "440", and a range increase of 500 nautical miles.

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change any of the reduction features.

Rapid calculation of the results of interactions of weapons and forces enables the battle to proceed in real time as well as to reflect the progressive capabilities of the forces at any given time during the action.

The Navy considers the Navy Electronic Warfare Simulator to be the first major attempt to construct a naval warfare simulator of this scope, and that operational experience with the installation will be required to develop its full potential. However, it considers that this inherent design characteristic makes the simulator an excellent tool with which commanders may obtain experience in the employment of forces in combat situations using modern weapons with the translation of weapon employment into damage effects.

The concept of using an electronic computer for this type of simulation is believed to be novel. Heretofore, when computers have been employed to assist in an analysis of various aspects of warfare, mathematical models describing a rigid situation have been inserted into the computer and an outcome, or series of outcomes, have been generated as the answer.

In the Navy Electronic Warfare Simulator, however, the situation is not rigid, and the electronic computer assists in the rapid assessment of weapon employment by the opposing commanders. Thus, their skill in exercising military judgment is an important element in the outcome. This factor the college considers to be essential in the realistic simulation of warfare for combat and provides command experience purposes.

The simulator incorporates provisions for the employment of 48 maneuverable forces which can be single or aggregated units with four types of weapons per force available. Weapons of the same type also may be aggregated. These forces are controlled locally by commanders located in the 20 command centers.

Each side, comprising 10 command centers, has 24 forces permanently assigned. The electronic components of the simulator have the capabilities of simulating the inflicting and sustaining of weapon damage to the same degree that actual forces would be susceptible to damage by real weapons.

These rooms simulate a flag plot, unit command combat information center, air command center, or tactical command center of any or all of the assigned forces on a side, in which the commander may observe and evaluate the strategic and tactical situation and exercise command.

In addition to simulated radio, intercom, teletype and navigational equipments, the command centers provide radar presentations and an electronically controlled automatic combat information center type evaluation of target information, giving the commander a continued over-all realistic presentation of the developing situation. He can then control his force or forces based upon intelligence information received.

The computer stores weapon effectiveness and target damage data. As firing action takes place, the damage computer determines hit probability and incremental damage per hit, accumulates the resulting damage and automatically introduces a reduction of maximum speed if appropriate, and weapon effectiveness of the target force in proportion to the damage sustained.

The umpires may eliminate this automatic feature manually, and may also modify hit probability, incremental damage and accumulated damage, as they consider appropriate. As a war game progresses, the effects of interactions between weapons and forces continually influence the courses of action that the commanders may take to carry out their missions.

Problems may be conducted in real time or speeded up to twice or four times unity time while operating in geographical areas of either 4,000, 1,000, 400, or 40 mi. on a side. Speeds up to 5,000 kt. may be used for forces operating in the 1,000 or 4,000 mi. area, and up to 20,000 kt. in the 4,000 mi. area.

The projector system in the umpire area is controlled by the navigational computers and provides moving images on the master plot screen. A historical plot of all forces is maintained on paper mounted behind the screen.

A force may be either an individual ship or aircraft, a task force, a shore installation, an airfield complex, or any maneuverable force that is capable of inflicting or sustaining damage. One such force may be aggregated to simulate an Attack Carrier Striking Force of carriers, cruisers and destroyers programmed with realistic characteristics of fire power and mobility, or the striking force may be represented by individual units up to 24 forces.

The umpires have facilities to monitor and influence the progress of the game. In addition to the composite view of the master plot screen, they can monitor the radar picture being displayed in any command center. They can see also the command center presentation which would appear except for the limitations set by the simulator to require radar line of sight and appropriate target size.

The umpires can monitor the communications of all commands and can introduce intelligence to the force commanders. They can control the characteristics of all forces and modify the output of the damage computer to weight or alter the battle situation.

# News Digest

**Nuclear-powered aircraft** studies will be continued through March, 1959, on the basis of a $2,671,557 contract awarded by Air Force to Convair Division of General Dynamics Corp. Study is under way at Convair-Fort Worth plant.

**Piper Papoose** is new "under $5,000" two-place private plane project being studied at Piper's Vero Beach, Fla., research and development facility. Currently Papoose design has side-by-side seating, a 90 or 100-hp. engine and tricycle landing gear. Piper hints that it is studying new methods of construction to hold man-hours and costs down. It does not foresee the Papoose reaching the market for several years.

**Light, stripped down rocket sled** with virtually no instrumentation aboard reached a speed of 2,853 mph., or about Mach 4.8, on the Holloman AFB 35,000 ft. track in September. Air Research and Development Command personnel believe that this is a new speed record for man-made devices traveling on the earth's surface.

**Research and development** flight test program for Army's Redstone 200-mi. tactical ballistic missile came to a close last week with a final firing from Air Force Missile Test Center, Cape Canaveral, Fla. Flight test program was begun more than five years ago. All Redstones fired from Canaveral in the last two years were produced by Chrysler, the earlier models by Redstone Arsenal, Huntsville, Ala. The missile has been on site with NATO forces in Europe since last June.

**Nord Aviation Griffon II** experimental interceptor recently clocked Mach 2.05 while in a climb above 50,000 ft. High speed run was achieved under control conditions at the French Air Force Test Center at Istres.

**Ryan Aeronautical Co.** has been awarded a quantity production contract by USAF for development of an advanced version of the Forebee jet drone. First phase of the program for the drone, designated Q-2C, calls for expenditure of $2,400,000. Full project is expected to run about $10 million, with production extending into 1960.

**Final decision** in the Mach 2-plus all-weather fighter competition between McDonnell F4H-1 and the Chance Vought F8U-3 will be made before the end of the year, according to Vice Adm. R. B. Pirie, deputy chief of naval operations. Both aircraft are now being evaluated at Edwards AFB, Calif.

# IATA May Soon Adopt Jet Surcharges

**Compromise jet surcharge of 10% may be adopted as airline leaders strike to halt fare dispute.**

By L. L. Doty

New Delhi—Possibility that extra fares will be adopted for turbojet flights on North Atlantic routes within six months has grown stronger as a result of efforts by airline presidents to find some compromise solution to the surcharge issue at the International Air Transport Assn. general meeting here.

Although no firm decision was reached during the meeting, it was evident that private talks by top managements of the carriers represented paved the way to more give and take between the two opposing forces in the jet surcharge battle. The controversial subject, which caused breakdown in negotiations at association's traffic conference in Cannes last month, was not introduced on the floor of the general meeting for fear that any open talks would merely bog down in a repetition of the Cannes deadlock (AW Oct. 27, p. 26).

Consequently, private discussions were conducted by airline heads behind closed doors between the business and social sessions of the meeting in hopes that some agreement could be reached that would justify an early reconvening of traffic conference.

Chances that continued disagreement on the jet surcharge issue could substantially weaken the IATA structure prompted the strategy of private discussions. Some delegates were concerned that the hassle on the surcharge issue threatened the continued existence of IATA as a major policy-making body.

### Fare Negotiations

Unanimous approval on all issues is required under the IATA charter before any decisions become effective. Failure to reach unanimous agreement on the fare issue could deny IATA the privilege of continuing negotiations of fares and place the job into the hands of governments involved. If such a practice were to be generally adopted in the future, authority of the traffic conference would be seriously undermined.

Standardization of fares normally is one of the provisions included in most bilateral air pacts, and governmental bodies can be expected to accept these bilaterals as a device to protect their flag carriers against the threat of an open rate war.

The position of the Italian airline Alitalia in support of the surcharge already is forcing U.S. and Italian governments to negotiate directly on fares to Rome and, unless airline presidents can come up with compromise offer acceptable to both governments, talks on fares at the government level could be expanded to include other countries. Italian insistence on the jet surcharge already has forced Pan American Airways to temporarily abandon planned Boeing 707 service into Rome (AW Nov. 3, p. 38).

Some delegates indicated to AVIATION WEEK that refusal to grapple with the surcharge issue on the floor of the meeting may have quashed the best chances the airlines had of reaching a final settlement among themselves. They said only commitments made during the actual business session could be considered binding and not likely to be revised during the weeks following the meeting.

These delegates also were critical of small amount of major business transacted during the five-day meeting despite a pointed appeal by IATA President J. R. D. Tata, of Air India, in his opening address that the full membership consider such problems as competition, fares, the used-plane market and rising costs. Of 86 member airlines, 22 were not represented at meeting. A total of 156 official delegates were listed on the roster, although some 250 had been anticipated.

### Meeting Value

During the meeting, an estimated nine hours were spent in actual business sessions. Veterans of IATA claim the real value of any general meeting is the opportunity it offers international airline heads to get together at least once a year, opening the way for a better understanding of one another's problems.

Indications are good that the surcharge debate was based considerably on this informal basis and that a surcharge of 10% above present first-class fares has an even chance of being adopted as a compromise. However, neither Alitalia, which wants a 30% surcharge, nor British Overseas Airways Corp. and Pan American, which want no surcharge, put a final stamp of approval on the proposed compromise as the association meeting came to a close.

Majority of the delegates agreed that, unless some decision is reached on the surcharge issue by the top managements involved, there will be no point in reconvening the traffic conference although it was hoped that a two-month

## TWA President Views Financial Outlook

**New York—Trans World Airlines' new president Charles S. Thomas believes financial conditions in the industry must improve or U.S. airlines may all be on subsidy within a few years. Squeeze of rising costs and limited fares is made more acute by labor conditions, with wage demands of pilots, mechanics and other personnel adding greatly to the costs problem.**

**Thomas, former Secretary of the Navy, finds the airline business the most interesting phase of his career so far after four months as TWA president. TWA's employes, he says, are a dedicated group eager for leadership. Under his presidency, task forces in each of the carrier's divisions are engaged in tightening up the entire operation, particularly scheduling. His approach is not to reduce personnel through the system to economize, but to add staff where indicated and reduce it where indicated.**

**The TWA head feels that one cause of the airlines' present problems is a too quick and heavy commitment to the jet age. On all but long hauls, the time advantage gained with jets, when ground time factors are considered, is not of major significance, Thomas notes. He quotes the late Ralph Damon, once TWA's president, to the effect that the airline business "is a race between technology and bankruptcy."**

**TWA's own heavy losses earlier this year won't be recouped this year, Thomas acknowledges. Picture may show improvement for 1958 as a whole, however, depending on firmness or softness of business during the remaining two months.**

**One disadvantage his predecessor, Carter Burgess, faced as TWA president, Thomas observes, is the fact that Burgess had never met Howard Hughes. Thomas, on the other hand, has known the TWA majority stockholder for some time.**

recess would serve as an effective cooling-off period.

The discouraging factor is that Alitalia's demand for a high surcharge is virtually a direct mandate from the Italian government. Many observers here feel that this fact will create a deadlock between the Italian and U.S. governments since the Civil Aeronautics Board probably will hold out for a surcharge of no higher than 5%. The CAB two years ago blocked a move by IATA-member airlines to boost the North Atlantic fare rate.

## British Match U.S. On Aviation Credit

**London**—Britain's Export Credit Guarantee Department can now match the terms of America's Export-Import Bank by insuring up to seven years' credit on large civil aircraft and aircraft engines.

The government's move in upping the period of cover—hitherto limited to five years—reflects the British aircraft industry's feeling it is losing foreign business to American planes because of easier American credit terms.

For insurance beyond the five-year period, the percentage of the total transaction covered would be limited to 60%—the present limit set by export-import—rather than the "normal" 85%.

In announcing the decision, Board of Trade President Sir David Eccles called it an "exceptional step," and said "we are as unwilling as we have ever been to start a credit race in regard to any particular exports."

Aircraft and accessories have been a major foreign currency earner for Britain. Exports are now running at about $434 million a year, but chiefly as a result of orders placed some time ago. Only two overseas airlines have placed orders for the de Havilland Comet 4, and only one for the new Vickers Vanguard turboprop. No foreign orders have been announced for the Vickers VC-10 or the de Havilland DH-121 jets, due in service in 1963-64.

## Flying Tigers Reports Gain in Net Profits

**Washington**—Flying Tigers reports a net profit of $1,307,782 for the fiscal year ending in June, crediting much of the gain over Fiscal 1957 to replacement of its Douglas DC-6 and Curtiss C-46 fleet with higher capacity Lockheed 1049H Super Constellations. Fiscal 1957 produced a net income of only $101,669. Total operating revenues were $33.8 million for the cargo carrier during 1958 as compared with $24.6 million for the previous year.

**Stabilizers Mated to Convair 880**

**Horizontal and vertical stabilizers are mated to Convair 880 jet transport fuselage at Convair Division's San Diego plant. First aircraft is scheduled for rollout in December, with first flight planned for early next year (AW Oct. 27, p. 41). Stabilizers are manufactured by Crosley Division of Avco Manufacturing Corp., which also makes the 880's wing leading and trailing edge sections.**

# CAB Approves Two-Year Plan In Pan American, National Pact

By Robert H. Cook

**Washington**—The Civil Aeronautics Board's formal approval last week of a two-year equipment lease proposal between Pan American World Airways and National Airlines is generally being interpreted by industry as an indication of the Board's willingness to approve all segments of the controversial three-part agreement between the two carriers.

Although its plan to approve the short-term lease was made apparent at the time CAB ordered a full-scale investigation of the agreement (AW Oct. 20, p. 40), Board members last week tentatively rejected arguments to disapprove the entire agreement on grounds of excess competition and possible control, through a stock exchange, of National by Pan American and said "public interest" should be the key deciding factor in any decision.

CAB approval of the two year lease should allow National to provide the first domestic commercial jet service in the nation on Dec. 10. Under the first phase of its agreement with Pan American, National will lease Boeing 707-120s from Pan American for two daily round trips between New York and Miami. National is advertising a southbound flight time of 135 min. for its jet service which it expects to expand to four daily round trips by April. The short-term lease covers the next two winter seasons, after which National will take delivery on its first Douglas DC-8 jet transports.

Under the long-term lease being investigated by CAB, the two carriers would then enter a mutual lease arrangement for the Boeings and DC-8s covering a 10-year period.

### Stock Exchange

Board approval for the short-term lease was conditioned on assurance from the carriers that they will submit for CAB review terms of the planned stock transaction which provides for a mutual exchange of 400,000 shares, and later option by Pan American for the purchase of an additional 250,000 shares of National stock, all of which would be held for an eight-year period by an independent trustee.

The Board also wants a final voice in selecting the trustees, written assurance that neither carrier will attempt to influence the corporate workings of the other while the stock is being held in trust, recognition of CAB authority over the agreement should the stock

transaction be disapproved and restricted use of the leased jets from any single-plane service beyond the New York-Florida route.

Spokesmen for the two carriers say there is little doubt that their companies will comply with the Board's terms, while the CAB apparently has satisfied many of its former objections to the three-part plan.

### CAB Concern

Among the major concerns expressed by the Board when it first ordered an investigation of the proposal was the competitive impact the lease proposal might have on other New York-Florida carriers.

In its approval of the two-year plan, the Board said it was faced with the prospect of rejecting the filing to protect Northeast Airlines at the expense of further weakening National. It added:

"Faced with this choice, we have little hesitation in concluding that the public interest lies not in preventing or hobbling effective competition which can be realized under the arrangements which have been made at the initiative of the management of National but rather in permitting implementation of such arrangements.

"While this will undoubtedly have a severe impact on Northeast, the remedy lies in Northeast's hands to make its own arrangements for competitive service. To take any other approach would tend to reduce service over a given route to the level established by the least effective competitor."

Northeast does not yet have any firm orders for jet transports to compete over the route with National. Eastern Airlines, the third competitor, is scheduled to begin Lockheed Electra turboprop service over the route on Dec. 1.

### Basis of Investigation

Basis for ordering an investigation of the long-term lease and stock exchange agreement was a CAB fear that the stock transaction could lead to possible control of National by Pan American.

This doubt was largely swept away when the Board told objectors to the agreement "in our judgement the opposing carriers have failed to make a convincing case in support of their contention that Pan American would exercise control over National during the period of the trusteeship."

Although the CAB specifically pointed out that its opinion of the stock phase of the plan, as voiced in the two-year lease approval, would apply only to the period pending completion of its investigation, most observers feel this Board philosophy will influence the final outcome of the investigation.

Further indications of possible CAB approval of the stock plan came with a Board observance that the airlines' stock, to be held eight years by trustees and voted only with a majority of other stockholders, was thereby covered by a "provision not normally found in the typical executory agreement." Such a proviso, the Board said, reduces "to some extent" the likelihood of a control situation.

Summing up their position, Board members said, "doubts which we expressed in the show cause order have been diminished to some extent by the suggested amendment of the option and stock agreement filed by Pan American and National on Oct. 17" plus the conditions imposed in the short-term lease approval.

In suggested amendment of the agreement, they offered to direct the trustees to return all stock to the issuing company, should the Board disapprove the exchange after its investigation.

Noting that its "acquiescence" in the trustee agreement was based partially on the "mutual interests" between the two carriers, the Board said any danger that Pan American may unduly influence National is not as substantial as in many merger or control proposals.

In approving the short-term lease, Board members said they recognized the difficulty Pan American would face in inaugurating international operations in competition with foreign carriers. Both the short and long-term leases, they added, should aid the carrier in attaining the utilization rate necessary for a profitable jet operation.

Even greater advantages may accrue to National, Board members said, since the short term lease will provide that airline with equipment to meet Eastern's Electra turboprop service. Pointing out that National has experienced heavy operating losses and has requested approval of the lease as a means of aiding in its jet financing program, the CAB concluded that there is "little doubt" that the proposed arrangements would substantially help the airline over its problems.

# Labor-Troubled Carriers Sign Mutual Aid Pact in Case of Strike

**Washington**—Strikebound Capital Airlines and five other major carriers facing labor disputes notified the Civil Aeronautics Board last week of plans to reimburse any strike-closed member of the group from any additional revenues they realize as a result of the strike.

Union reaction to the mutual aid pact, signed by Capital, American, Eastern, Pan American, Trans World and United airlines and retroactive to Oct. 20, was immediate and included charges that the carriers are engaging in strike breaking and violating anti-trust laws.

CAB spokesmen say the airlines may legally go ahead with the plan, pending a full Board hearing of the issue. A prehearing conference before CAB examiner Leslie G. Donahue is scheduled for Nov. 20.

With Capital and the International Assn. of Machinists deadlocked after three weeks of strike, most observers last week viewed the pact as a means of sustaining the carrier in its running battle with the union. IAM negotiators have repeated their intentions of holding out for a 42-cent-an-hour pay raise, and the outcome of the Capital strike is expected to set the wage pace for contract, negotiations with Eastern and Trans World, where IAM has called off proposed strikes, and with Northeast, Northwest and National airlines. By late last week, Capital had come to within four cents of the union's demands with the proviso that a three-year contract be signed.

### Capital Prime Beneficiary

Since the plan is retroactive to within four days after the beginning of the Capital strike, the airline would be the first to benefit from the financial aid.

Even if the CAB rejects the pact, the time consumed in completion of the formal hearing should still give Capital time to collect some revenue from other members of the agreement. With its entire operation halted, and all possible expenses reduced or eliminated, observers say the pact money could spell the difference between the airline successfully holding out against the IAM demands or acquiescing to union wishes.

## Douglas, Boeing Consider Small Jets

**Washington—Douglas Aircraft Co. is considering production of a smaller, short-to-medium-range version of the DC-9 medium-range jet transport originally planned two years ago (AW Sept. 13, 1956, p. 26).**

**Douglas has queried approximately 60 airline operators as to the sales potential of the smaller jet which would operate over stage lengths of between 300 and 2,000 mi.**

**Boeing Aircraft Co. also is reportedly interested in the possible market for a smaller version of its 707 which would be designated the 707-727 and include trailing pod mountings on either two or four-engine models to reduce interior noise level.**

Approval of the mutual aid pact would have a strong effect on such unions as the International Assn. of Machinists, Air Line Pilots Assn. and the Flight Engineers International Assn., all of which recognize the agreement as the first united effort between airline competitors to present a solid defense against the unions.

As presented by the airlines to the Board, the pact is designed to "counteract the effects of excessive labor demands" and encourage acceptance of Presidential Emergency Board recommendations. The carriers singled out the IAM, in particular, as "undermining" the position of the presidential board as a last resort in collective bargaining disputes.

Mentioning the Capital strike, the airlines said their agreement is intended to cover both present and future labor difficulties.

Officials at the IAM headquarters, however, declined to make a statement on the new issue, saying that they were preoccupied with contract negotiations.

Most abrupt reaction to the pact came from the Flight Engineers International Assn. which stated that, should its members strike against one of the signers only to find that the airline is collecting mutual aid, FEIA will strike against all of the other remaining pact members.

Urging the Board to "head off a full scale war" in the airline industry, the engineers' union accused the six carriers of joining together for the purpose of union breaking and warned that it would not stand by while "unions and years of effort are submerged in an airline profit pool."

Most immediate answer to the airline-aid pact, the engineer's union contended, is to seek common consent of all airline unions to support one another to retain the right to strike and negotiate. The practice is now in effect at Eastern Airlines, where the FEIA local has joined with the mechanics and cabin attendants in a pledge to honor the picket lines of a striking member. Union spokesmen say similar agreements with other airline locals will be signed with the near future.

Pointing out that Presidential Emergency Board recommendations are not binding under law, the union said the carriers used emergency board findings to split unions and turn one against the other. Branding the pact as the product of an "illegal, immoral cartel," FEIA asked the Civil Aeronautics Board to reject the airline proposal or face the prospect of a united labor front in the airline industry for the purpose of breaking the combine.

The Air Line Pilots Assn. said CAB approval of the agreement would force it to start a "war chest" for a strike fund and might possibly lead to an industry-wide strike by its members.

Both unions, however, expressed doubt that the Board will permit the airlines to carry out their agreement on the grounds that it would constitute a violation of anti-trust laws, force the Board into a strike-breaking role and into approving the underwriting of an exchange of strike revenues.

Union arguments of anti-trust violation were discounted by attorneys for the carriers, and legal experts of the Department of Justice said later that they doubted if any questions of such violations were involved in the pact.

Approval of the plan would automatically exempt the airlines from any threat of a possible anti-trust violation, while disapproval would result in referring the case to the Department of Justice for a ruling on the question, according to spokesmen for the Civil Aeronautics Board.

## Sud Caravelles Near Completion

**Five Caravelle jet transports, being built for Varig Airlines of Brazil, Air France and Scandinavian Airlines System, are in the final assembly line at Sud Aviation's Toulouse, France, plant. Aircraft on order by Finnair, Air Algerie and Royal Air Maroc are now in the sub-assembly stage at Toulouse. A more powerful version will be available in 1961, with advanced cruise speed and range and maximum gross weight raised from 99,000 lb. to 106,000 lb. New engines will be stage 5 versions of Rolls-Royce Avon RA.29 turbojets, producing takeoff thrust of 13,000 lb. each. Production models now are equipped with Avon RA.29s in two models, producing 10,500 and 11,700 lb thrust respectively.**

# TWA Now Reserving Space Electronically

**New York**—Trans World Airlines last week formally put its Teleregister Corp. electronics reservations system into operation at six cities on the airline's coast-to-coast domestic system. First phase installation connects data processing units at New York, Chicago and Los Angeles with TWA's inventory control center in Kansas City. Agent sets in San Diego and San Francisco offices are tied in with the Los Angeles system, and Milwaukee is tied in with Chicago.

Inventory control at the center is still accomplished manually, but a later phase of the program is expected to include automation of this process. Under the present setup, seat availability and other information is instantly provided through the agent sets from memory drums. When a sale or cancellation is made, the information is keyed from an agent set to a drum, which codes and teletypes it automatically to Kansas City. The control center in turn informs the drums by teletype when a flight is sold out.

The three data processing units will store space availability information on all TWA domestic seats for 31 days and up to six months on overseas flights, the airline says. The system handles four classes of service on the same aircraft, displays four separate conditions of seat availability and provides the control center with waiting list requirements. It displays availability on eight flights to a given destination, providing a passenger with alternate choices if a preferred flight is sold out.

Phase II of the program will involve automation of the inventory control and linking of additional U. S. cities. Third phase will extend the system to overseas points. No time schedule for the expansions has been set.

Cost of Phase I is estimated by TWA at $3 million over an eight-year period. This includes installation and lease of the tele-register equipment.

# GREATER PROFIT POTENTIAL FOR SHORT-SECTOR, HIGH-FREQUENCY ROUTES

**Low operating costs**... best of any postwar aircraft in this category ... designed for low break-even load factors on local service operations.

**Proved popularity—big capacity**... Viscounts have boosted load factors an average of 35% worldwide ... new plane will accommodate 54 to 65 passengers with ample baggage and mail space.

**Dependable, economical Rolls-Royce power**... four Rolls-Royce Dart 506 jet-props ... unsurpassed for economy, ease of maintenance, length of overhaul cycle (TCA reports 1900 hours, test engines to 2000) ... 300 mph at 10,000'.

**Fast intermediate servicing and terminal turn-around** ... can operate up to five 100-mile sectors without refueling and with a minimum of ground handling ... integral, hydraulically-operated stairs ... safe, simultaneous on-and-off loading of passengers on left, freight on right.

**Jet Age growth for local service carriers and the areas they serve** ... faster schedules and modern jet-prop equipment mean *new* business traffic and accelerated growth ... size of Local Service Viscount is adequate to absorb future payload increases.

*For information, contact: Christopher Clarkson, U.S. representative, 10 Rockefeller Plaza, New York 20, N.Y.*

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## New Aircraft Broker Purchases 25 DC-7s

**Washington**—New life is being injected into the used-plane market as a result of plans reported by two aircraft dealers, including a newcomer on the scene, to buy substantial numbers of piston-engine aircraft from airlines as they are replaced by jets.

Both companies already have completed major transactions in which they will acquire 57 two-and-four-engine planes from the airlines within the next few months. At the same time, both said these transactions were only the beginning of extensive programs to buy equipment for re-sale or lease.

New firm on the scene is the General Aircraft and Leasing Co. Inc., with headquarters in Washington, a newly organized firm to be headed by Milton W. Arnold who resigned as vice president-operations-engineering of the Air Transport Assn. (AW Nov. 3, p. 25). Other is Frederick B. Ayer & Associates of New York, an established dealer.

Arnold said his company, as its first transaction, will buy 25 Douglas DC-7s from American Airlines, with delivery beginning Jan. 1. The aircraft will be for either sale or lease, Arnold said. Arnold said last week that his firm was organized to buy, sell, lease and otherwise deal in used and new aircraft, aircraft engines and equipment.

Ayer & Associates, who earlier announced the purchase of 24 Convair 240s from American Airlines (AW Sept. 22, p. 43), reported last week that it had purchased two Douglas DC-6Bs from Continental Airlines for delivery within the next nine months and is in the market for a substantial number of others. The firm also has acquired six Convair 240s through the purchase of the Dundell Corp.

## Irish Airline Plans New European Routes

**London**—Aer Lingus plans three new continental routes for next year. Subject to government approval, the airline will operate from Dublin to Lisbon via Lourdes; to Copenhagen via Manchester and Dusseldorf, and to Rome via Paris and Zurich.

To meet competition on the Manchester-Zurich route, the Irish airline will terminate its present Dublin-Manchester-Zurich-Rome service at Zurich next year. The Dublin-Lourdes-Barcelona and Dublin-Lourdes-Rome services will be maintained.

First deliveries of seven Fokker Friendship aircraft will begin next month to replace company's Douglas DC-3s on services between Ireland and Britain.

## The Control Battle

According to numerous 'Letters to the Editor' printed recently in Aviation Week, we are in the midst of another see-and-be-seen, IFR-VFR (positive versus no control) name-calling battle. But we have enough trouble on our hands without fighting each other. Fact is that at the present time there is no choice. Depending on conditions, we must use combinations ranging from 100% VFR, through 50-50, to 100% IFR in order to achieve maximum safety aloft.

Since most midair collisions have occurred during VFR weather there has naturally been considerable agitation for a 100% IFR system. As a matter of fact, there is little opposition to this. The problem is more a question of "ifs". That is, if 100% IFR would not reduce freedom of flight, and if the required airborne equipment could be put into all aircraft, and if there would not be extensive traffic delays, etc. When these "ifs" can be satisfied we will probably find 100% support for 100% IFR.

### "See or be Seen" Dependency

How much can be said for VFR? Unquestionably, a great deal. If all windshields were painted black the collision rate would no doubt go up (if anybody would take to the air, that is). Recent experiments to render aircraft more conspicuous by the use of "shocking pink" paint apparently have merit. On the other hand, situations occur daily which illustrate the folly of depending too heavily on "see and be seen." In terminal areas, for instance, aircraft can, and do, report their position with great accuracy (i.e. "Over Yankee Stadium", etc.) This knowledge, along with altitude, should allow one to pinpoint the aircraft with ease. Yet pilot after pilot reports no sign of the ship despite concentrated staring. It is simply that aircraft are difficult to see.

This also tends to refute the premise that larger windshields would be the answer. Actually too much glass creates other problems—some of which are rather nasty to live with.

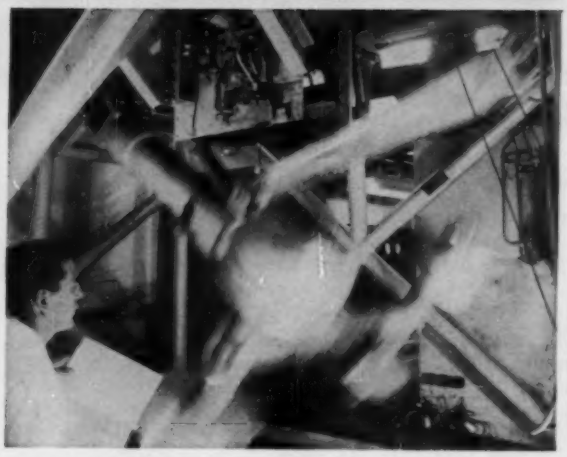
After the last midair crash the military airports in the Washington, D. C., area went "all IFR." The limitations of ATC soon became apparent when this extra surge in business produced take-off delays of four and five hours. Obviously it was a question of VFR or not at all.

There has, of course, been an improvement in traffic control in the past few years. It is difficult to see exactly where this improvement has occurred since the increase in traffic consistently negates beneficial innovations. Such things as ALPA's Golden Triangle and the more recent CAA positive control planning have been steps in the right direction. Trouble is that we are no longer able to patch and piece the old system—we need a new method.

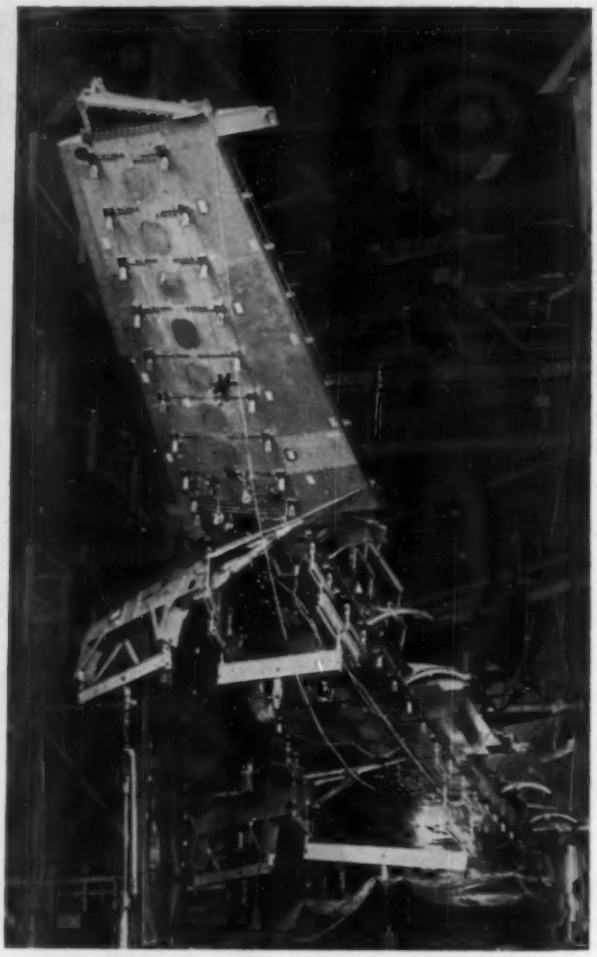
### Limited Knowledge

Some of the confusion over the proper remedy for the mess stems from our tendency to work from a limited knowledge and to judge, too quickly, the affairs of others. All pilots do have certain things in common and yet different types of flying require emphasis in different places. The pilot of small aircraft has a lack of equipment to contend with; the military jet, besides lack of equipment, finds check points laid out for "horse and buggy" flying, and the airline pilot must contend with the demands of multi-engined aircraft cockpits.

These various climates inevitably produce differences in outlook and suggestions for cure. Until a miracle comes to pass we will have to use all possible ways and means to avoid collision in the air. And of these various remedies the most important of all might be termed the common sense, alert operation of aircraft.



**8,000 CYCLES.** Structural integrity beyond that of any other transport aircraft was designed and built into the Boeing 707—and proved out in more than four years of prototype test-flying and ground testing of components. Landing gear, above, was put through 8,000 test operating cycles.



**TORTURE RACK.** A KC-135 jet transport-tanker recently completed a 15-month static test, culminating in a test-to-destruction to determine its absolute limits of endurance. During the test, loads were applied to force wing-tips through a 16-foot arc. Flaps, spoilers, engine mounts, rudder and other components all *proved* capability of taking far greater stresses than would conceivably be encountered in flight operations.

**TANK TEST.** Though Boeing has built more pressurized aircraft than any other company, jet aircraft fuselage is put through underwater cabin pressurization tests to simulate 50,000 high-altitude "flights." During each cycle, loads simulate normal flight loads, such as those imposed by take-offs, cabin pressurization, wind gusts and landings, plus passenger and cargo weight.

**"TEAR-STOPPERS",** shown in the picture above, confine any possible damage to limited areas—even damage inflicted in tests by a heavy steel blade. Throughout, the 707 and the shorter-range 720 benefit from the wide experience Boeing has gained in building more than 1,600 large, multi-jet aircraft—more than any other manufacturer in the world.

*These airlines already have ordered Boeing jetliners:* AIR FRANCE • AIR INDIA • AMERICAN • B.O.A.C. • BRANIFF • CONTINENTAL • CUBANA • LUFTHANSA • PAN AMERICAN • QANTAS • SABENA • SOUTH AFRICAN • TWA • UNITED • VARIG • *Also* MATS

**BOEING**
Family of jet airliners

# Local Carriers Favor New Subsidy Plan

By Ford Eastman

**Washington**—Plans for a drastic revision of Civil Aeronautics Board rate making procedures for local service carriers (AW Nov. 3, p. 25) are generally regarded by the airlines as a big step toward permitting the small carriers to become self sufficient.

Although the CAB plan is far from complete, the basic formula already outlined is expected to at least serve as a starting point in developing a new procedure acceptable to both the industry and the Board. The proposal, drafted by the CAB staff after consultation with industry representatives, was the main item last week on the agenda of the Assn. of Local and Territorial Airlines meeting in Honolulu. It suggests that local carriers be paid a monthly subsidy based upon a pre-determined portion of a standard cost of operation per plane mile, including a reasonable profit, for a given number of frequencies over each route segment. The percentage of cost paid would decrease as the number of trips increases, and the government and the carrier would share annually in all profits above a given profit level in accordance with a pre-determined and fixed ratio. Standards established would be applied on an industry-wide basis.

Sam I. Aldock, special assistant to the director, CAB Bureau of Air Operations, says the plan's advantages are:

- **It would give the CAB better** control of subsidy payments by eliminating negotiation and substituting a fixed price list so that both the carrier and the Board would know in advance just how much subsidy would be paid for specific operations.
- **It would give carriers a fixed** dollars-and-cents standard by which they could judge their own performance, and managements would have more freedom to conduct operations as their judgment dictated.
- **Carriers, because they would** know the sum of their subsidy payments in advance, would have greater financial stability, could attract financing needed to purchase more modern equipment.
- **Plan would simplify procedures** by eliminating lengthy and costly temporary and final mail rate hearings, reducing time and costs to both the carriers and CAB staff.
- **Profit-sharing would give** carriers an incentive to work toward profitable operations by rewarding the carriers directly according to their achievements.

One possible disadvantage of the proposed plan is the difficulty in arriving at a single over-all cost standard that would be applicable to all carriers with any degree of equity in view of the substantial differences between the market and operating characteristics of the various carriers. However, if the cost standard eventually established is found by any carrier to be inadequate, it could seek remedy.

The rate-making methods now in use were formulated when Congress passed the Civil Aeronautics Act to meet the subsidy needs of trunkline carriers, a group with significantly different economic characteristics than local service airlines. For a variety of reasons, James R. Durfee, CAB chairman, has admitted, these methods do not appear to be working in the best interests of local carriers or the public.

Until now, subsidy payments were made according to a temporary rate determined by the Board and based on the break-even need for each individual carrier. The carrier could operate at a temporary rate for an indefinite period, but the final determination of the subsidy payments and the future rate, which would include a reasonable rate of return and other allowable expenses, would be set at a final rate proceeding.

### Difficult Position

During rate procedures, Durfee said, the Board was constantly put in the position of reversing management judgment on a hindsight basis, often with respect to decisions as to equipment and scheduling practices. In many instances, he added, the Board was faced with the choice of making disallowances that might cripple a carrier or allowing expenditures that, in the CAB's judgment, should never have been made.

In many cases, costs in certain expense categories have been disallowed irrespective of whether the carrier had exceptionally low costs in other categories for which there is no reward.

The picture is further complicated by the fact that, if the Board's rate is established for a future, or closed, period, the actual operational experience may turn out to be substantially different from that forecast by the CAB. This could be the result of spiraling costs, increased mileage due to route awards or other unforeseen trends.

Under the proposed plan, the following standards would be established:

- **Cost per plane-mile,** including a reasonable profit.
- **Average yield per passenger-mile.**
- **Number of passengers per trip.** This standard would be higher for each successive daily trip over a route.

The mileage payment per trip would be determined by subtracting the product of a standard minimum amount of traffic, which would be increased as the number of trips increases, and a standard fare yield from a standard cost per plane-mile.

The CAB staff said the net effect of this formula would be a payment that would produce a reasonable profit if the carrier met the standards built into the computation. Or, it would produce profits under or over the predetermined level considered reasonable if the carrier operated at a cost level different from the standard or charged a rate per mile above or below the standard fare or developed traffic over or under the minimum level.

Under the profit-sharing plan, carriers realizing a profit after taxes of up to 10% of their investment would retain the entire amount. On profits ranging between 10% and 20% of the carrier's investment, the carrier would retain 50%, and the government would receive 50%.

When a carrier's profit ranges from 20% to 50% of its investment, the carrier would retain 25% and the government would receive 75% of that amount. Above 50%, the carrier would retain 10%, and 90% would be returned to the government.

Revision of the CAB's rate making machinery has been one of the major goals of the Assn. of Local and Territorial Airlines under the guidance of Joseph P. Adams, executive director and a former CAB member. The Air Transport Assn. also has joined with the group in seeking a change.

While the plan is being made final, the CAB has offered interim relief by revising its policy on temporary mail rates, which already are in effect. Temporary subsidy will be paid at the maximum reasonable level and will be designed to meet interest charges on long-term debt and other cost items in addition to the carrier's break-even need.

## Heliport Study Group Appointed by CAA

**Washington**—First official action to set U.S. heliport design and development criteria has been taken with the Civil Aeronautics Administration appointing a nine-member industry-government committee to study problem.

Philip A. Hahn, chief of the Engineering Division of CAA's Office of Airports, was named chairman of the group which includes three other CAA officials and representatives of the Air Line Pilots Assn., Aircraft Industries Assn., Air Transport Assn., American Assn. of Airport Executives and the Airport Operators' Council.

J. B. Wassell, Director of Engineering, with Lockheed since 1937

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## SHORTLINES

▶**Air Line Dispatchers Assn.** elected Capital Airlines dispatcher Robert E. Commerce as a full-time president of the group at its recent San Francisco convention. Commerce, who will take a two-year leave of absence from Capital, was selected from a field of 21 candidates. Sam Kinsey, also a Capital dispatcher, was re-elected to the office of part-time secretary-treasurer.

▶**British Overseas Airways Corp.** has put its winter schedules into effect, featuring daily Bristol Britannia and, on Nov. 14, de Havilland Comet 4 service from New York to London. The airline says the Comet 4s will take over the company's "Monarch" luxury service, replacing Boeing Stratocruisers. The Britannias will be used on regular first-class and economy flights. BOAC will also operate its Douglas DC-7Cs on its New York-Boston-United Kingdom routes on a four flights per week basis.

▶**Eastern Air Lines'** board of directors has declared the year's fourth regular quarterly cash dividend of 25 cents a share, and the additional annual dividend of 2% in stock, both payable Dec. 15, to shareholders of record as of Nov. 14.

▶**Lockheed Air Service Inc.** has received a fixed price per service contract for work on three Douglas DC-4 aircraft presently assigned to passenger and cargo operations on California Hawaiian Airlines in the U.S. and the Far East.

▶**KLM Royal Dutch Airlines** opened its final link in its round-the-world service Nov. 1 with the inaugural flight from Amsterdam to Tokyo on the Polar Route. The Dutch carrier plans to operate the new route on a twice weekly basis using the following routing: Leave Amsterdam for Anchorage for a fuel stop, continuing to Tokyo and Biak, New Guinea, and returning to Amsterdam along the same route. KLM is using Douglas DC-7C aircraft on the flights.

▶**Southern Airways** reports first three quarters earnings before taxes of $132,000. After income taxes, the airline had a net profit of $63,000, or 25 cents per share on 252,400 shares of common stock outstanding. Southern President Frank W. Hulse says that the favorable earnings were the result of adjustments in mail rates approved by the Civil Aeronautics Board. The current year would be the sixth consecutive profitable year for Southern.

## AIRLINE OBSERVER

▶Civil Aeronautics Board is facing renewed criticism from foreign flag carriers who complain that the Board is the only major government agency that has failed to recognize the economic relationship of management decision to the profitable performance of jet transports. European representatives of international airlines claim industry growth is being hampered by CAB refusal to accept trends in traffic set by normal development of air transportation.

▶**General Services Administration, which controls the purse strings for civilian agency traveling, is emerging as a powerful opponent to airline demands for increased fares in the General Passenger Fare Investigation. GSA objected to the 6.6% increase granted in February and said it cost the agency $858,000 more a year in travel fees, the Department of Defense $4 million. Each 1% increase costs GSA $130,000 annually, the agency said in a brief to CAB examiner Ralph Wiser. Any general fare increase, it added, should be awarded only as a "last resort."**

▶First scheduled Fairchild F-27 turboprop transport service will be inaugurated on Nov. 14 by Piedmont Airlines. The local-service carrier will place its first Fairchild on a route serving Winston-Salem, Bristol, Lexington, Cincinnati, Greensboro, Raleigh, and Wilmington, N. C.

▶**Russia has inaugurated Tu-104A jet service on its 2,175 mi. route between Moscow and the Central Asian city of Alma-Ata near the Chinese border. The 70-passenger Tu-104s make the flight in 4 hr., 20 min. as compared with an estimated 18 hr. for piston engine Il-14s.**

▶Addition of new four-engine equipment raised the U.S. airline fleet total to 1,864 aircraft as of last Jan. 1, according to the Civil Aeronautics Administration. CAA also reported a total of 67,153 active aircraft registered as compared with 64,688 for the previous year.

▶**El Al Israel Airlines expects to realize a profit this year after suffering heavy losses in 1957. Last year's losses were attributed to the introductory costs of the Bristol Britannia and a decline in traffic caused by the Near East flareups.**

▶Most foreign flag carriers now support the principle of continuous heating of fuel at the fuel system filter of turbine engines as the best possible solution to filter icing.

▶**Watch for Air Line Pilots Assn. to be dropped from the International Transport Workers Federation. Top ITWF officials fear the ALPA stand demanding a third pilot for jet transports in the flight engineer's position could lead to union raiding by the pilots' organization. They have given ALPA until Dec. 12 to change its mind, or the union will be forced out of the federation. They charge that ALPA's stand violates an agreement signed with ITWF two years ago providing that no crew member shall be merged into another union membership without prior approval of both labor organizations.**

▶Public demand for jet flights has increased reservation requests for Pan American flights to Europe by an estimated 320% for the Oct. 26-31 period as compared with the same period last year. The carrier reports that load factors on its daily roundtrip Boeing 707 flight to Paris averaged in excess of 90% during this period, with the highest load factors recorded on westbound return flights.

▶**Look for stepped up battle against domestic and international airlines by their travel agents on matters of rates of commission, club-type charter operations and use of credit cards. American Society of Travel Agents is prepared to carry its fight against the conference system itself if necessary. International Air Transport Assn. recently rejected ASTA's request for increased commissions and Air Transport Assn. is still studying a similar request. Good travel agent-airline relationship is important in developing the new business needed to fill the forthcoming fleets of jet transports.**

SUNDSTRAND

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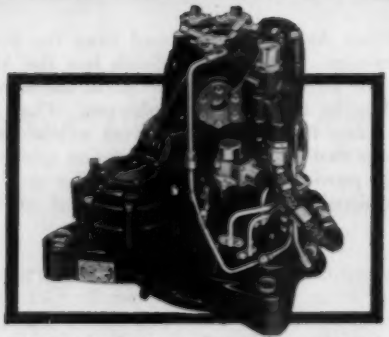

"Package-type" unit in drive system custom-engineered for the Boeing 707 jetliner to meet space, mounting, and kva requirements. Generators can be paralleled, automatically if desired, require little or no monitoring by the crew.

## Facilities and People

Materials research requires extensive laboratory equipment like this x-ray spectrographic unit. Metallography, wet chemistry, etc., are widely used in Sundstrand R&D work.

Continuous component testing includes specialized equipment like .this 15,000-lb output force shaker. Vibrations created exceed severest flight conditions.

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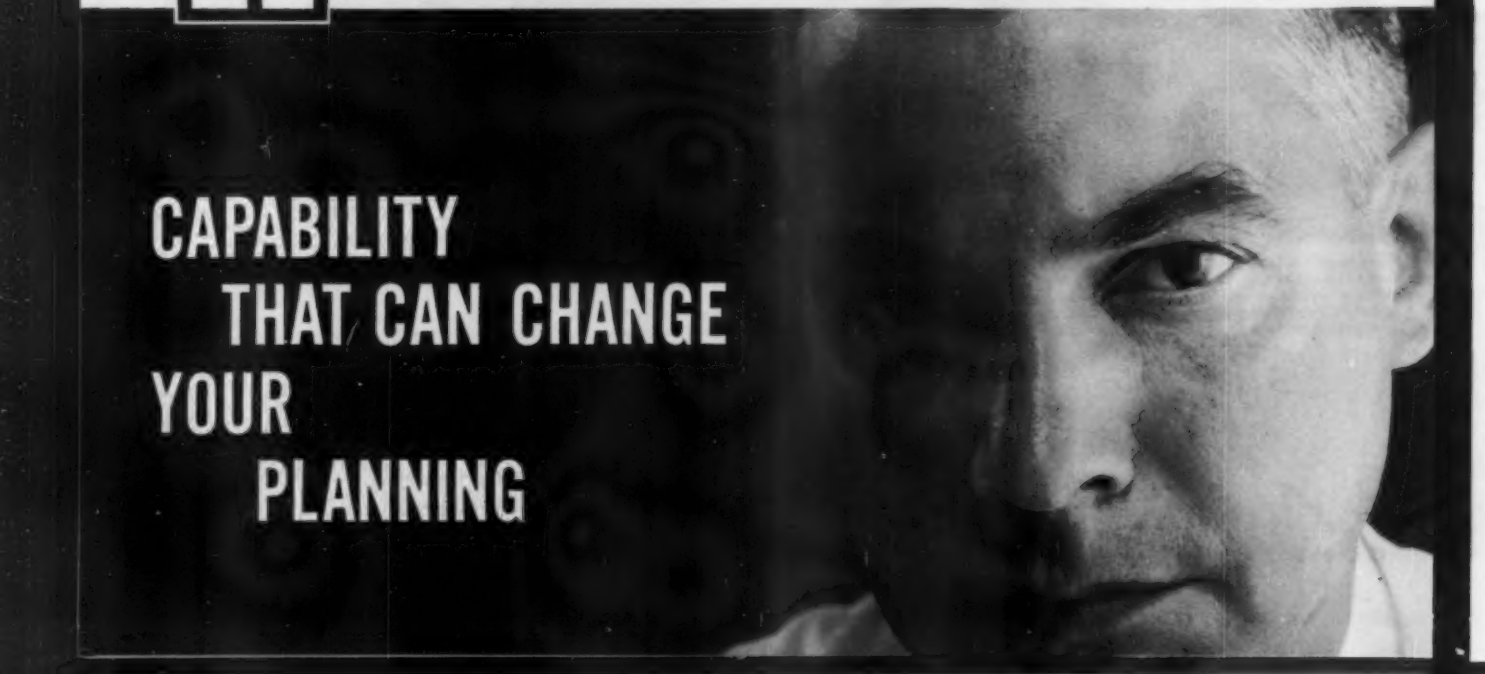


# Sealing Results in Black Knight Changes

By John Tunstall

**London**—Sealing problems forced extensive fabrication changes during development of the Black Knight, AVIATION WEEK learned from Charles E. Tharratt, chief trial engineer, during a recent tour of the High Down, Isle of Wight, test site.

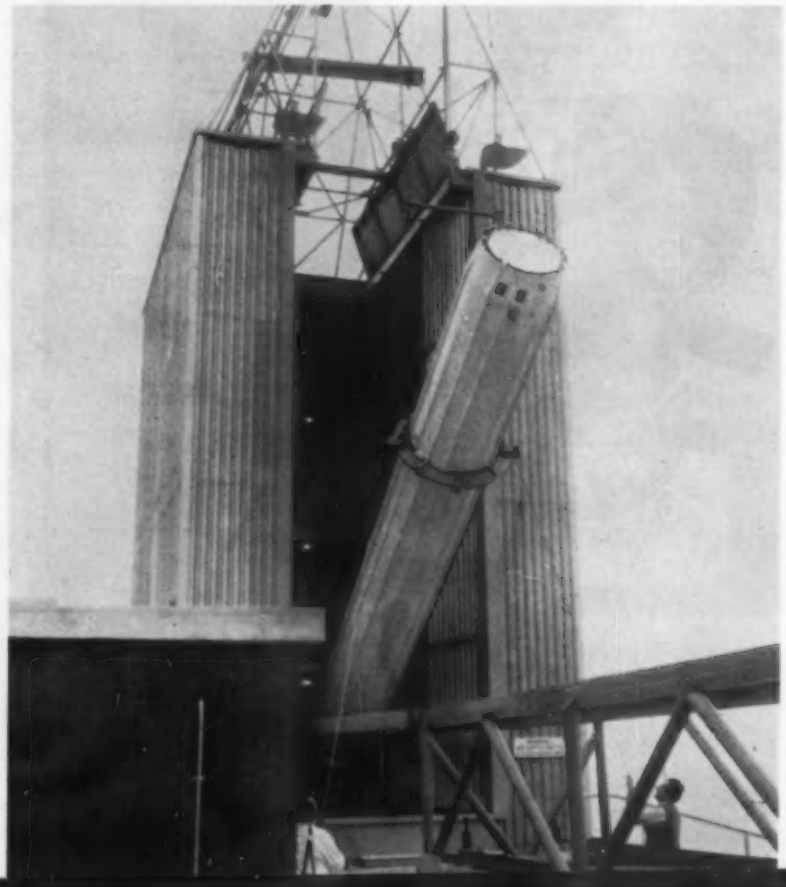
Airframe has integral fuel tanks and is pressurized with air. The early airframes used for structural testing had 16 external bowler hat stringers riveted to the skin. Skins and stringers were wrapped round internal ring frames and closed and sealed with a single longitudinal bolted joint. Many sealing compounds were tried but all tended to relax after a period under load, creating a leak hazard.

Method now used is to stitch-weld internal frames to the skin, forming cylindrical sections which are butt-welded together. Stringers are mostly intercostal and have been taken inside and welded to the skin. Because of the very thin skin used (22-24 S.W.G.) and the relatively large diameter of the cylinder, a special welding machine was developed for the operation.

The structural efficiency of the Black Knight (AW Sept. 22, p. 50) owes much to the use of internal pressure loading. Tensile stresses developed pneumatically neutralize some of the pure compression stresses and help stabilize the skin under non-axial loading in flight. But AVIATION WEEK was told that the differential pressure used and method of applying it will remain among the more closely guarded secrets of the vehicle.

Also classified is a method of maintaining differential pressure as the vehicle fills and empties. During one phase the vessel blows off and at another, internal pressure is probably boosted from a small compressed air supply.

Although the oxidant used in the Black Knight has not been officially revealed, little attempt is made to conceal the use of HTP (high-test peroxide) at the site. A steaming hot water tank laid open on the ground between the two test gantries was to help people "take an unceremonious dive" if contaminated with HTP, AVIATION WEEK learned. It had widely been thought that liquid oxygen was the oxidant used because of the association of both designers and manufacturers of the Black Knight's rocket motors—Royal Aircraft Establishment, Westcott and Armstrong Sid-



**PAIRED** static test towers (above) used in Saunders-Roe Black Knight development program are at High Down, Isle of Wight, test site. Test vehicle rounds are brought in on transporters, erected outside test stand and moved into position by overhead beam crane. Flame deflector pits direct exhaust blast toward the sea. Blockhouse for both stands is dug into hillside behind them and is just visible (right center). Trailer of concentrated hydrogen peroxide, Black Knight oxidizer, is partially screened by hill at left. Size and layout of test stands hint at possible use for pre-flight checking of complete Blue Streak rounds (AW Sept. 15, p. 30). Below, an early Black Knight round is lifted into the test gantry. Structure was changed in the production version to overcome sealing difficulties.

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**PERFORMANCE** characteristics of an "850" include flat frequency response 0–70 cps, down 3 db at 100 cps (10 div. peak-to-peak amplitude) . . . thermal drift eliminated by current feedback power amplifiers . . . limiting at input to prevent amplifier saturation or cut off, so that damping is never lost . . . drift less than 0.2 div. for 20° to 40° C. changes, line voltage changes from 103 to 127 volts . . . gain stability better than 1% with 20° C. and 20 volt changes . . . linearity 0.2 div. over 50 divisions . . . clear, permanent, inkless recordings in true rectangular coordinates.

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(All data subject to change without notice)

deley Motors respectively—with kerosene and liquid oxygen engine development in Britain.

Motors in the Black Knight are each mounted on a simple trunnion giving one degree freedom.

The design was committed to for separate motors before Paul L. Leyton, chief rocket development engineer, took over.

He told AVIATION WEEK that the main attraction of the arrangement included the relatively high state of development of the basic engine and ancillary units used.

Another reason was the fact that four trunnion-mounted units was a much simpler mechanical proposition than the gimbal-mounted unit needed with a single motor.

No special features are mentioned in connection with the Black Knight rocket motors, the thrust of which have been unofficially estimated at about 5,000 lb. each.

### Range Increase Attempts

Leyton said attempts to increase the range of Black Knight depended on weight-paring of both structure and motors rather than on increased fuel tankage.

He stated that only slight modifications had been made, based on the results of the first firing, but he said he could not forecast when the second firing would take place.

The test site was developed at very low cost because of its being sited on cliffs which greatly facilitated excavation operations and because the site had previously served as a military fort and possessed a network of underground passages.

Cooling water problems were also simplified as the flow simply discharges down the cliff side into the sea.

### Gantry Installations

Gantry installations are basically the same as those used at the firing range. Rocket is supported on a simple tubular structure from a single ball and socket joint.

Central observation blockhouse is equipped with periscopes focused on the flame zone of each rocket, and with override controls in the event of a misfiring.

Waterjets lined up with access holes in the engine bay are supplied from the blockhouse.

Test program is set up on a "Swiss block" and is automatically sequenced. Instrumentation is largely conventional and the recording room provides facilities for up to 200 channels. Equipment includes photographed oscilloscopes and magnetic tape recorders. Batteries of 20-channel mirror galvanometers are used for recording higher frequency responses.


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# a FLYING SUBMARINE?

AMPHENOL engineers and laboratory test group refer to 67 Series MINNIE connectors as "flying submarines." It started as only a humorous name but it is actually a quite accurate description of these miniature "E" connectors. Here's why. The performance conditions under which MINNIE connectors will operate are exactly like those of a submerged submarine—flying at 80,000 feet altitude!

Another description for "flying submarine" is *altitude-moisture resistant*. Under a new test devised by industry and the military, wired MINNIE's are completely submerged in salt water and altitude cycled to 80,000 feet for one minute, to 65,000 feet for one half hour and then returned to ambient pressure for another half hour.

Following this test, the minimum insulation resistance of MINNIE connectors is 1000 megohms, well in excess of the 100 megohms required by MIL-C-5015C after moisture.

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# Space Biological Research Tests Need Instrument Improvement

By Craig Lewis

**San Antonio**—Faced with limitations in size, weight and available techniques, medical electronics specialists are working hard to improve the instrumentation used to measure the physiological condition of space travelers.

In spite of some recent developments, the state of the art in instrumentation for biological research on both man and the lower animals in isolated environments is fairly rudimentary. New devices will have to appear before medical researchers will be able to do an efficient and complete job of measuring the biological factors involved in submarine, balloon capsule and space vehicle operations.

Requirements vary with the size of the animal being studied in isolation and the stresses it will experience. But the rapidly advancing need for efficient, advanced instrumentation is evident from the approaching flights of the X-15 and from the plans of both the Air Force and the Navy to develop equipment that can put animals, and later man, into orbit.

Actually, men and animals have already gone into space in the kind of cramped quarters that could make good use of lighter, smaller, more efficient biological instrumentation. Man High and Stratolab balloon flights have carried men to altitudes where measurement of their physiological condition was vital. The dog in Sputnik II and the mice in the Thor-Able nose cones were also prime subjects for biological study.

**OXYGEN SENSOR** developed by Dr. James R. Neville of the USAF School of Aviation Medicine is shown attached to a meter. The nylon cell is about 1½ in. x 2 in. It offers a simple, small, lightweight means of measuring oxygen partial pressure in a space ship or any other isolated environment.

For a small animal like a mouse, researchers have to rely mainly on environmental data to gage its condition. A mouse is too small to hook much instrumentation on, and the practical limit is probably an electrocardiogram signal to get the heart rate. With larger animals, more measurements are possible.

The kinds of measurement biological scientists want to take directly vary somewhat with the specific experiment, but generally they are, in order of priority: heart rate, rate and depth of respiration, blood pressure, body temperature, oxygen partial pressure of the inspired air and carbon dioxide partial pressure of the expired air.

Other measurements researchers want are the electrocardiogram and electroencephalogram, and oxygen tension of the blood. It would be useful to have television films of the subject unless he wore a mask which would obscure his facial reactions to space conditions.

## Essential Measurements

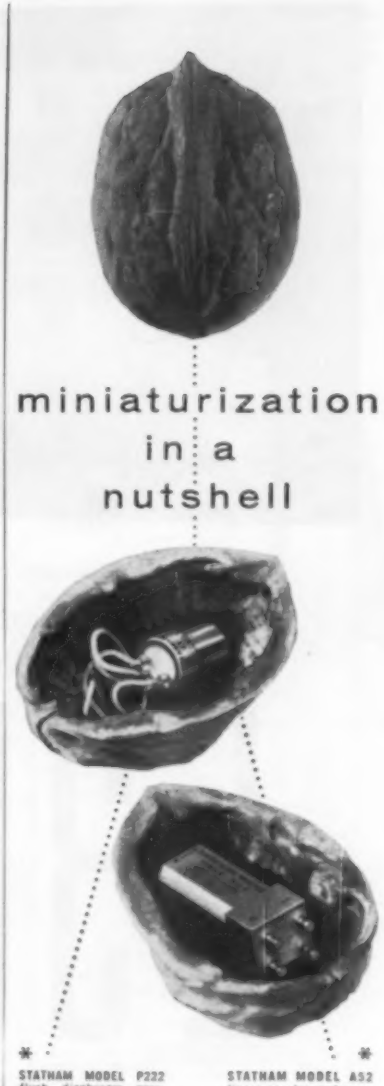
Environmental measurements considered essential are: cabin temperature, total pressure, oxygen and carbon dioxide partial pressure and the acceleration profile. Measuring humidity is also valuable because of its effect on the temperature of the subject.

Instrumentation for these environmental measurements is not as big a problem because engineers measure most of these things in normal airframe test work, and the equipment already exists. Engineers would not be measuring ionizing radiation levels, however, and a detector of the same general type used in the Explorer satellite will be needed.

The basic problems lie in the field of telemetering the measurements taken directly from the isolated subject to the ground where they can be read or recorded. The telemetry itself is fairly standard, and the data processing equipment is standard. The problem lies largely in developing sensors to take the measurements on the body and send the signals to the telemetering gear for transmittal to the ground.

Navy has been working on the problem of telemetering physiological data for several years and has developed a capability for telemetering several types of this information. With the expanded interest in space flight in the past year, the tempo of research in this field has picked up at many establishments, including the USAF School of Aviation Medicine here at Randolph AFB.

Work currently under way at the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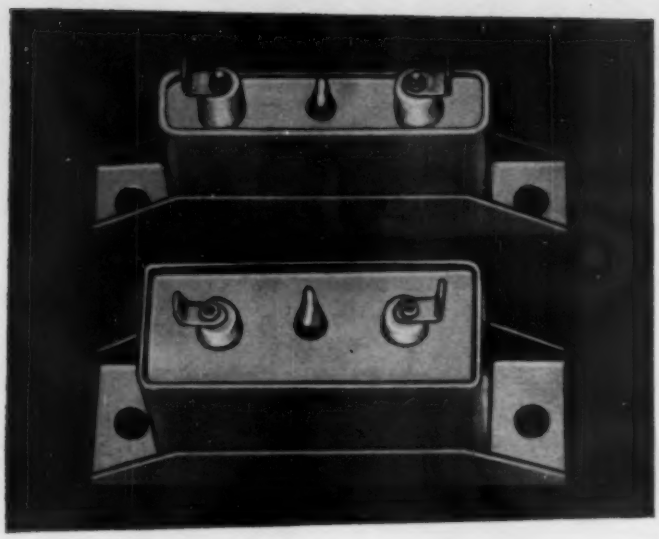

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This nonpolarized capacitor is available in a variety of sizes in a capacity range of from 0.05 to 4.0 microfarads at 600 VDC. It is also available in higher voltage ratings. Performance data and operating characteristics are given in Technical Bulletin SL-61 which is supplied upon request.

*Confirmed by qualification test of 1000 hours at 100% rated voltage over ambient temperature range of −55° to +315° C.

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school is described as "adapting known techniques to medical use" by Capt. Ray W. Ware of the Department of Physiology-Biophysics. Researchers are involved basically in developing sensors which can translate physiological signals into usable telemetering signals, according to Ware.

### Oxygen Sensor

New device developed here by Dr. James R. Neville is a marked improvement in equipment for measuring oxygen partial pressure. It is a very small, light oxygen sensor which operates on polarographic principles, and in certain applications it will replace much larger and heavier equipment now used.

The new sensor is a nylon cell which has a gold working electrode with a polyethylene membrane over it to contain a very thin layer of saline electrolyte. Oxygen diffuses through the membrane and is chemically reduced when it hits the gold electrode. Because of electrochemical reaction, current flow is produced from the gold electrode to a reference electrode which is directly proportional to the partial pressure of the oxygen in the ambient air.

Oxygen sensor requires no external electric power to operate it because the oxygen is spontaneously reduced. A suitable output resistor is installed across the two electrodes, and the self-generator is fed into a measuring device. Signal can be fed directly into telemetering equipment. Output ranges up to about 200 microamperes in an environment of pure oxygen. A patent application has been filed on the new sensor.

This sensor provides a transducer that can measure oxygen partial pressure in extreme environmental conditions. One model is about 2 in. and extremely light, and other models are the same general size. A small version has operated for two weeks, and larger ones are expected to last much longer. The sensor can measure oxygen in air, but it is also small enough to fit into a mask system and measure directly the oxygen content in the air going into the space flier's lungs.

### Carbon Dioxide Sensor

A closely allied problem is the development of a carbon dioxide sensor to replace the bulky infrared absorption system where weight and space limitations are of paramount importance. Dr. Neville is working on a device in the same size and weight class as his oxygen sensor, an operational instrument has not yet been perfected.

Measurement of the rate and depth of the space traveler's breathing can now be done with a respiratory volume sensor that is an adaptation of a commercially available device. Using a

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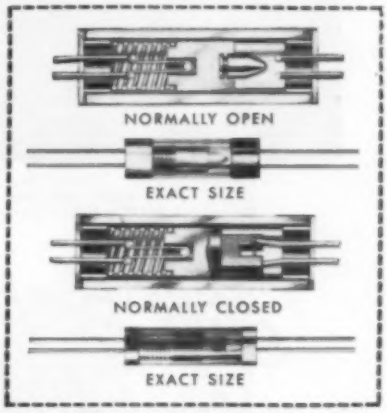


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*Colonel Gregory "Pappy" Boyington, U.S.M.C. (Ret.)* Though no longer an active flyer, "Pappy" maintains a deep and lively interest in the progress of aviation. He is shown here being "checked out" in the cockpit of an F8U-1 Crusader, Chance Vought's 1000 m.p.h. plus fighter built for the U. S. Navy.

*still keeps 'em flying!*

Colonel Gregory "Pappy" Boyington, U.S.M.C. (Ret.), is a fabulous figure whose daring exploits as a World War II fighter pilot wrote a bright page in the history of America – a dark one in the history of her enemy.

Ex-Flying Tiger, and leader of the Marine Corps' famed Black Sheep Squadron –"Pappy" Boyington relives his experiences in his autobiography, "Baa Baa Black Sheep," published by G. P. Putnam's Sons.

"Pappy" is now Sales Manager of the Aircraft Sealant Division of The Coast Pro-Seal & Mfg. Co., one of the country's leading processors of sealants based on THIOKOL liquid polymers.

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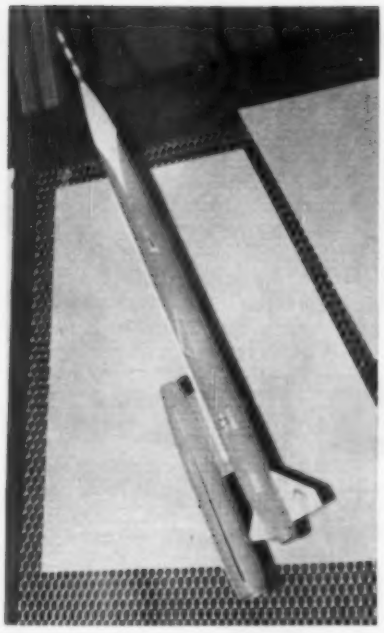

**Beech Supersonic Target**

**First photo of Beech project design PD-121 drone target system, is one of a family of proposals company has developed for Army's coming high-and-low-level competition. Firm will submit its proposal in December. Some 94 contractors attended Army discussions on new competition. PD-121 has tiny delta wing, combines jet and ramjet (under fuselage) power.**

modification of the hot wire thermocouple, this flow meter has the advantage of being able to measure rapidly fluctuating flow rates while offering essentially no resistance to gas flow.

In the past, most airborne measurements have been limited to the rate of respiration, but this device can measure depth as well.

Since it is small and tubular in shape, it fits easily into the oxygen hose in a face mask.

### Measuring Heart Activity

Measuring heart activity in an isolated subject is a major problem for biological researchers. Ideally, they would like to get a measure of cardiac output, which is the combined product of heart rate and stroke volume. Existing techniques call for inserting needles into the subject's blood vessels, or at least putting a sensing device around a blood vessel.

This is an example of the kind of laboratory techniques which are out of the question for taking measurements from an isolated subject. Such a direct method of gaging cardiac output requires medical supervision, and researchers could scarcely expect to stick a needle in the operator of a space vehicle.

Dr. Ware told AVIATION WEEK that any direct measurement of cardiac output on human subjects in flight is ruled out by the present state of the art, but researchers would like to find a way of measuring blood flow accurately in a nondestructive manner.

The compromise accepted is to record pulse rate and blood pressure, a crude measure of cardiac output, by the routine technique a physician uses in his office. Since this ordinarily requires a doctor, a certain amount of automation has been necessary.

A lightweight plastic cuff is wrapped around the subject's limb, and the cuff must be confined by an inflexible covering to keep all pressure internal. The sleeve of a pressure suit will do the job. A timing device with a pneumatic valve periodically inflates the cuff. As cuff pressure falls off, it reaches the point where it is equal to blood pressure in the blocked vessel, and the blood begins to flow through again.

A physician senses this moment when the blood starts to flow again with a stethoscope applied to the blocked vessel just down from the cuff. This is the systolic measurement. He gets the diastolic measure when sound-producing turbulence disappears from the blood stream with an isolated subject, a microphone replaces the


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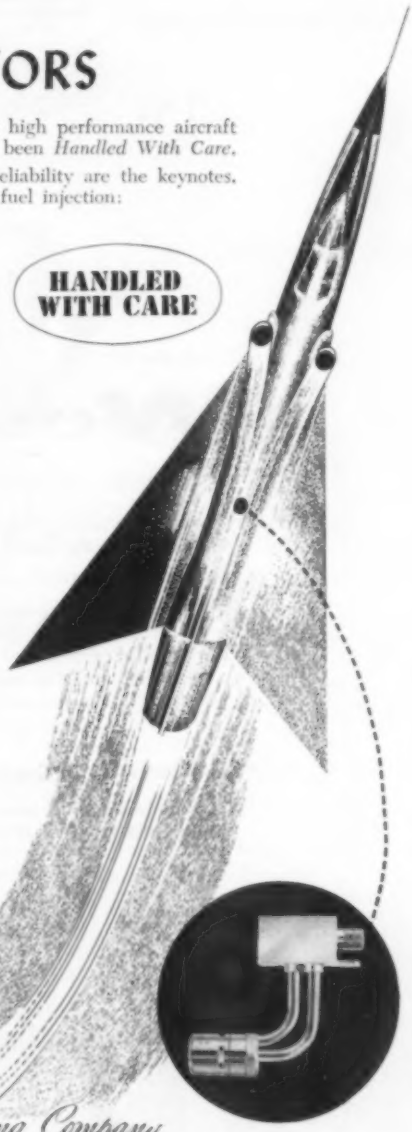


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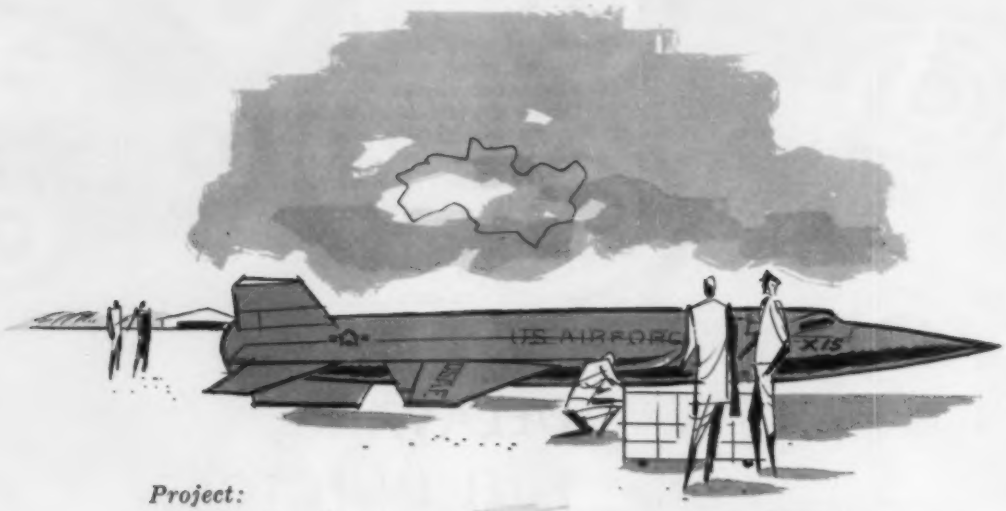


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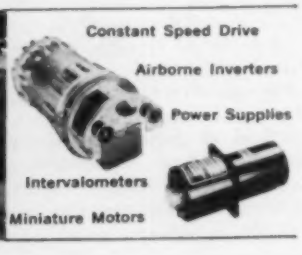
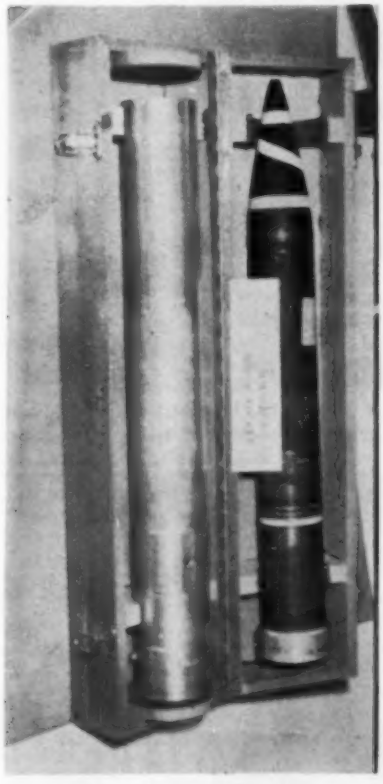


stethoscope on the blood vessel, and synchronous recording of cuff pressure and microphone signals gives a blood pressure reading.

Heart rate is a byproduct of this system, as it is of other physiological measurements, the same type of electrical pickup used in the physician's office is employed. Leads have to be placed carefully to avoid getting signals from muscle masses in a moving subject, and the top and bottom of the chest seem the most practical spots. The electro encephalogram has similarly been recorded in flight.

A method for investigating peripheral circulation in the body is under development by Dr. Samuel R. Powers, Jr., at Albany Medical College, N. Y., under USAF contract. Dr. Powers electronic impedance plethysmograph measures changes in volume of a zone of tissue between two electrodes—for instance, the area between the knee and ankle.

This instrument permits study of circulation and blood flow in the area, and replaces the cumbersome water displacement technique.



**Dervish Missile**

First view of Northrop 2.75-in. Dervish missile was initially developed as replacement for Mighty Mouse air-to-air rocket, then proposed to Army for ground-to-air use. Spin-stabilized Dervish is powered by solid-fuel TRX 126B Thikol rocket motor.

## Missile Site Plumbing Gets Special Cleaning

**Tulsa**—Techniques proven in the chemical and refining industries are being used by Dowell Division of Dow Chemical Co. to clean the intricate plumbing of missile launching complexes.

Dowell cleans fueling and other systems in the missile pads and launching complexes when they are first constructed, and reclcans the systems whenever the equipment is dismantled for repair or modification.

Cleaning job must meet close specifications set by the military agencies operating the missile facilities. Dowell must meet standards of 25 microns on particle size, and for hydrocarbons, there must be no incandescence under 3,500 negatrons of infrared.

Some parts of the launch pad plumbing can be dismantled and removed for cleaning in vats, but other parts must be cleaned in place. Dowell uses acids, caustics, degreasing solutions and solvents for the job, varying the cleaning agent with the different metals being cleaned.

As a result of its missile facility work so far, Dowell is suggesting the use of welded piping in the systems to make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the cleaning job simpler. Welded pipe is recommended because it provides better sealing and there are no gaskets in the pipe joints to collect contaminants.

Dowell also has a Dow-developed anti-corrosive additive for use with corrosive materials.

For the cleaning job at the Air Force facility at Cape Canaveral, Dowell designed special trucks with stainless steel equipment and special filters. Use of the trucks with their special cleaning gear lends mobility to the operation.

In addition to the work at Cape Canaveral, Dowell has done similar work for the Martin Co. at Denver and will clean the launching pads at the new ICBM base at Warren AFB, Wyo. Company also does chemical cleaning for the Army at Redstone Arsenal and is working on the first Bomarc installation in Florida.

## Survival Influences Polaris Performance

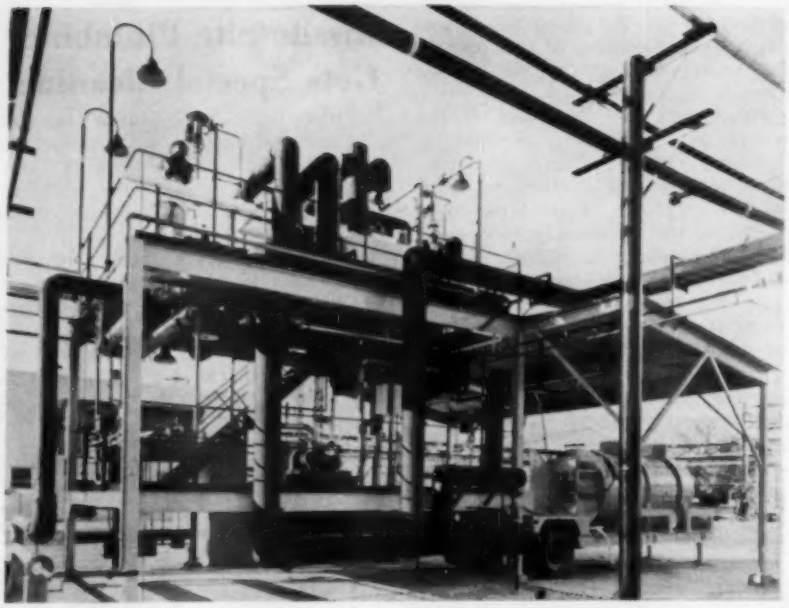
**New London, Conn.**—Lockheed Missile Systems Division has found that factors affecting human survival under prolonged submerged cruise conditions are directly influencing company design of Navy's Polaris fleet ballistic missile.

It was discovered early in Polaris development that certain materials which might be innocuous to humans over a short period of time could become potentially toxic air pollutants when inhaled for prolonged periods. More generally, the company pointed out that man and his ability to survive in the hostile environment he will encounter under the sea and in outer space will be the limiting factor in the development of the advanced submarine or space vehicles of the future. It was also predicted that similar human-performance limitations could delay more advanced vehicle programs by a year or more—and perhaps influence the basic design of the vehicle.

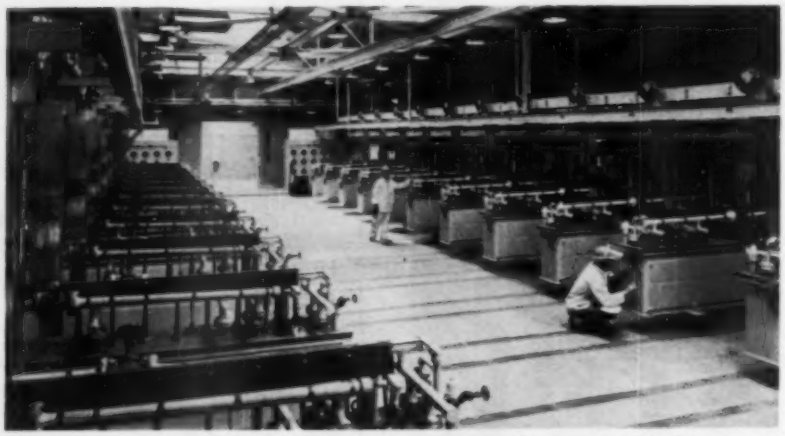
It was disclosed that certain factors of human survival, with which human engineering research is concerned, may alter appreciably a vehicle system which the company previously had on its design boards.

## Nuclear Engine Shielding Studied by Boston Group

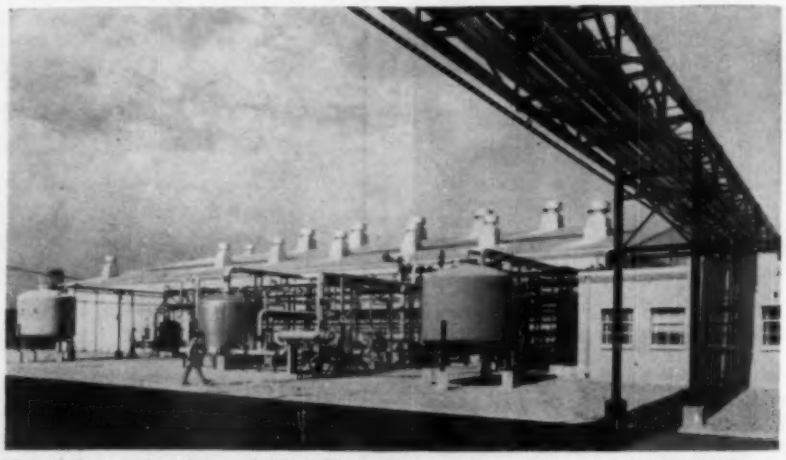
Development of materials able to contain nuclear engines operating at temperatures up to 5,000F will be an initial project of Nuclear Metals, Inc., in its new facility at Boston, Mass. Company also will investigate uses of tungsten, molybdenum, tantulum and niobium in $2 million Metallurgical and Development Laboratory.



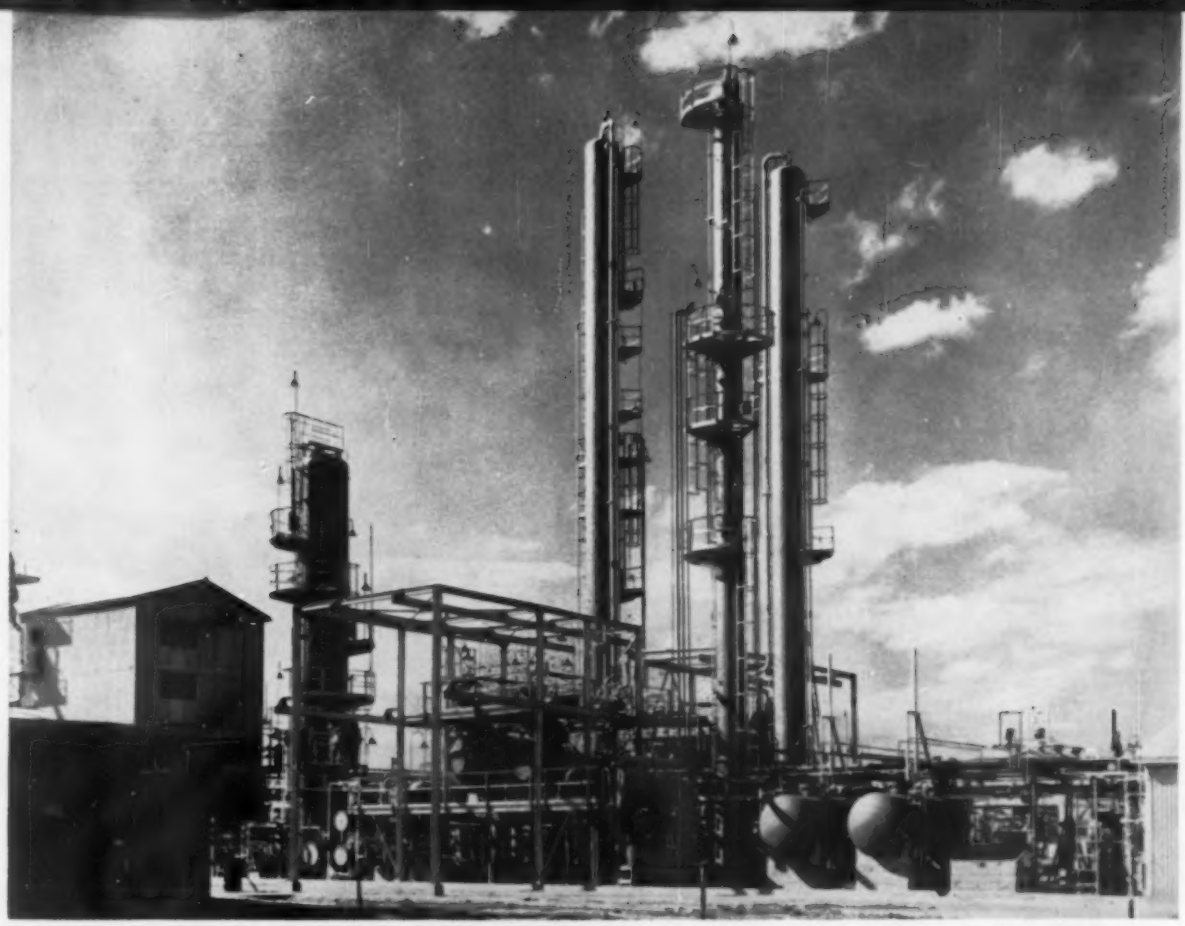
Gaseous fluorine (Allied Chemical Corp.) is piped here from cell room. Here it is purified and liquidized through refrigeration with liquid nitrogen, then loaded in tank trucks.



Flourine is produced electrolytically in cell room through the separation of hydrogen and fluorine from hydrofluoric acid. Allied plant includes several rows of fluorine cells like these.



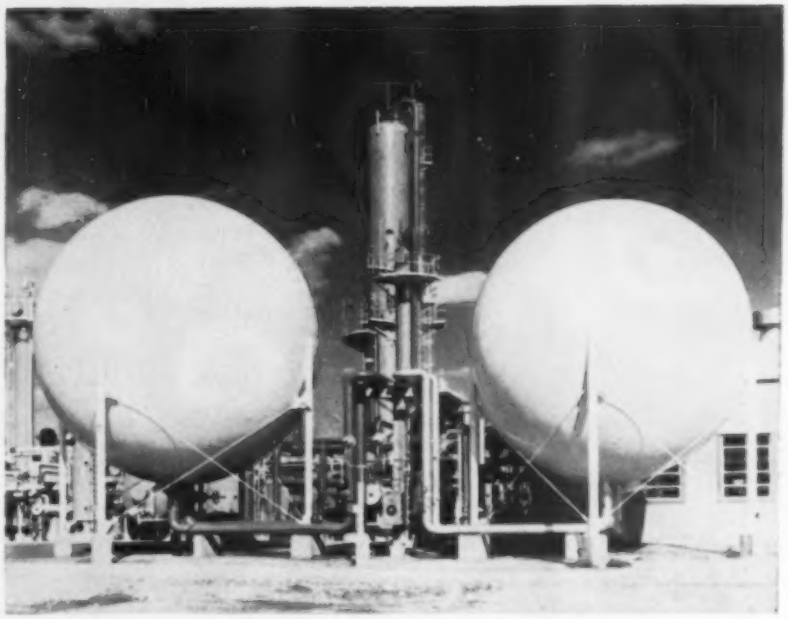
This is the exterior of part of Allied Chemical Corp. General Chemical Division's Metropolis (Ill.) Works fluorine plant. Auxiliary process equipment is shown here.



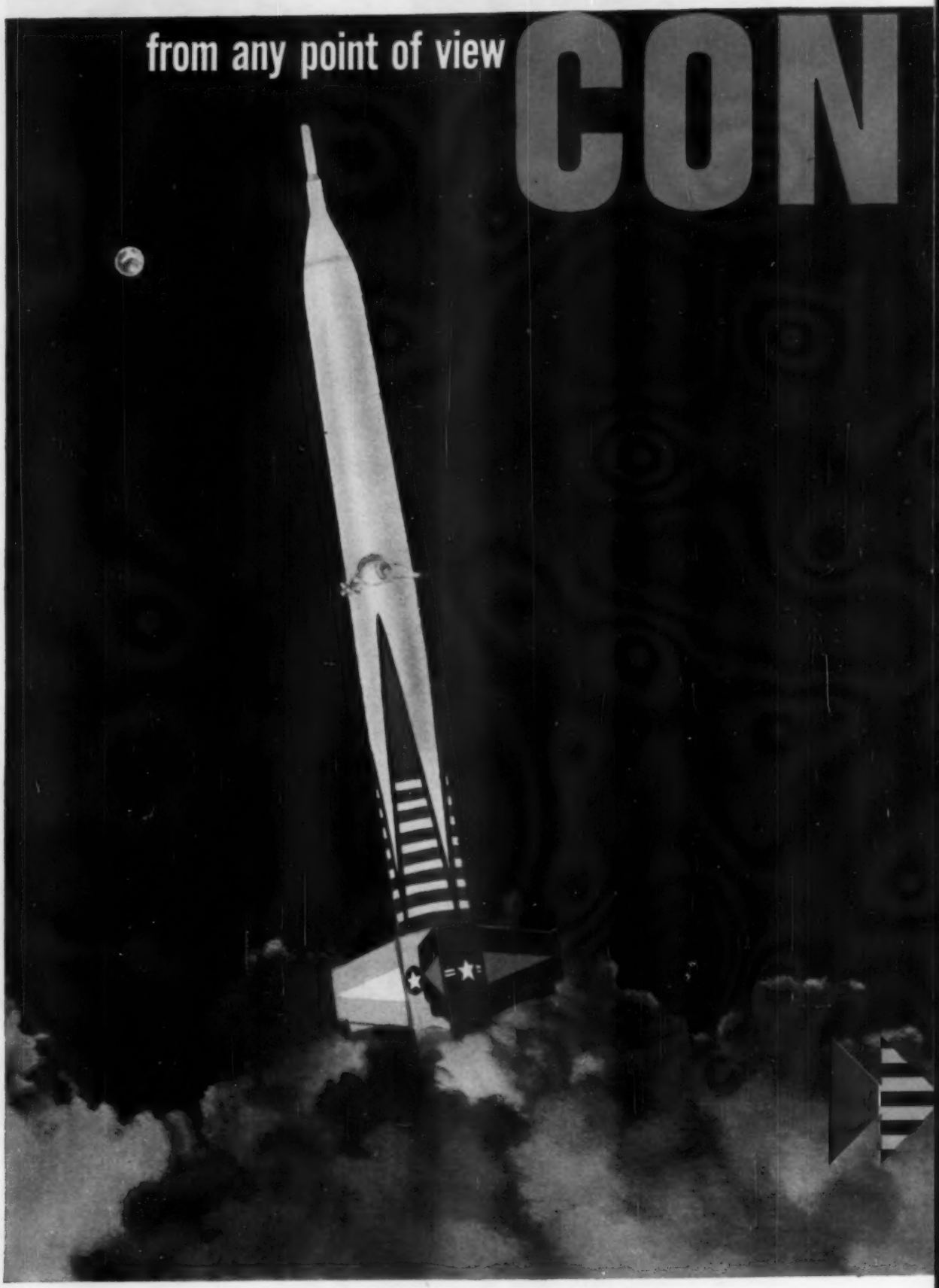
Boric acid, other raw materials are converted at Callery into an intermediate chemical in first step of HiCal production.

# Plants Begin High-Energy Propellant Production

Allied Chemical Corp. and Callery Chemical Co. have begun large-scale production of high-energy propellants. Production of liquid fluorine at Allied Chemical's General Chemical Division plant at Metropolis, Ill., is the first step in production of $UF_6$ for a U. S. Atomic Energy Commission program, through refining of uranium oxide compounds. Capacity is sufficient to also supply tonnage quantities for rocket and missile use, according to Allied. Fluorine is delivered in both gas and liquid forms in tank trucks. Tank truck units comprise three inner tanks which contain insulating mediums. Fluorine in the innermost tank is cooled below its —306F boiling point to keep it in a liquid state (AW Feb. 24, p. 63). Rocket engine research has utilized fluorine in an effort to produce an oxidizer with an extremely high specific impulse. Callery Chemical Co. has built a $38 million high-energy fuel plant for the Navy which will produce tonnage quantities of boron-based fuel next year. This fuel, called HiCal, will be used extensively by the Navy in turbojet and ramjet propulsion tests which are expected to determine the most practical and productive uses for the fuel, according to the company. Plant is located in Muskogee, Okla.



Pure nitrogen is stored at low pressure in Callery Chemical Co. sphere at left; pure carbon dioxide is stored at low pressure in right sphere. Tower in center separates the gases.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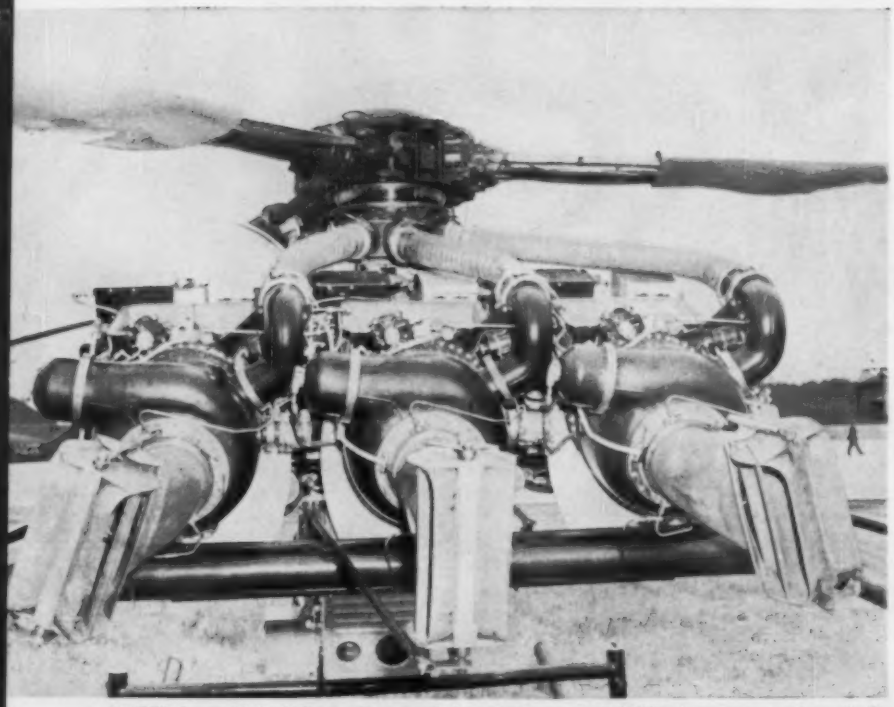
**WIDE-TREAD** large-diameter skid landing gear provides McDonnell 120 with large "footprint" for operation off soft, uneven terrain.

# Three-Turbine McDonnell 120 Shows



**DUCTS** from triple AiResearch uncowled compressors feed 350F air to rotor, automatically anti-icing all-metal blades. Engine overhaul period is tentatively set at 500 hr.

By Erwin J. Bulban

**Ft. Belvoir, Va.**—Triple-turbine powered lightweight McDonnell Model 120 helicopter is aimed at providing Army ground troops in battle areas with a versatile low-maintenance flying crane having a maximum useful load to empty weight ratio of 1.5:1 while also featuring engine-out safety.

Quick getaway and rapid climb, demonstrated here recently by McDonnell, had the Model 120 off the ground in less than 35 sec. after the pilot energized the first of the three engine-starting switches and he climbed vertically at an estimated 1,500 fpm. while carrying a 1,650-lb. 75-mm. howitzer slung under the fuselage. Without a cargo load, the 120 has a climb rate of some 3,500 fpm. At the conclusion of the demonstration, the pilot took off and climbed vertically on two engines at a rate of about 1,000 fpm.

Model 120 can carry approximately a ton over 80 naut. mi. at cruise speed of more than 100 mph. Crane configuration, which inherently also provides a low silhouette to the enemy, permits rapid attachment of bulky items such as a 105 mm. howitzer or a jeep-type vehicle while the aircraft

**NARROW** fuselage permits good visibility.

# Crane Ability

is on the ground. Location of cargo hook under the rotor hub minimizes center-of-gravity travel problems.

Variety of loads conceived by McDonnell engineers includes various configurations of pods and personnel kits consisting of two long "toboggan-type" seats capable of holding 12 men with Fiberglas shields to protect occupants from rotor downwash and wind blasts.

As a tactical weapons carrier, for offensive action against ground troops, the Model 120 is capable of being fitted with 96 2-in. rockets or 48 2.75-in. rockets clustered in tube launchers.

McDonnell is not overlooking possible Navy shipboard applications; the company points out that Model 120 is capable of operation even under high winds—basic rotor configuration has been started and stopped in wind forces of 100 kt. Model 120 measures: length, 20 ft.; height, 9 ft.; rotor diameter, 31 ft., landing gear skid tread, 9 ft. 2 in.

For use in aircraft crash fire fighting, the small crane can carry a fire fighting crewman, a medical attendant, 200 gal. of foam under operating pressure of 100 psi. and a crash entry kit. Four litter patients may be carried on return trip from fire scene. In general fire fighting, such as forest blazes, the

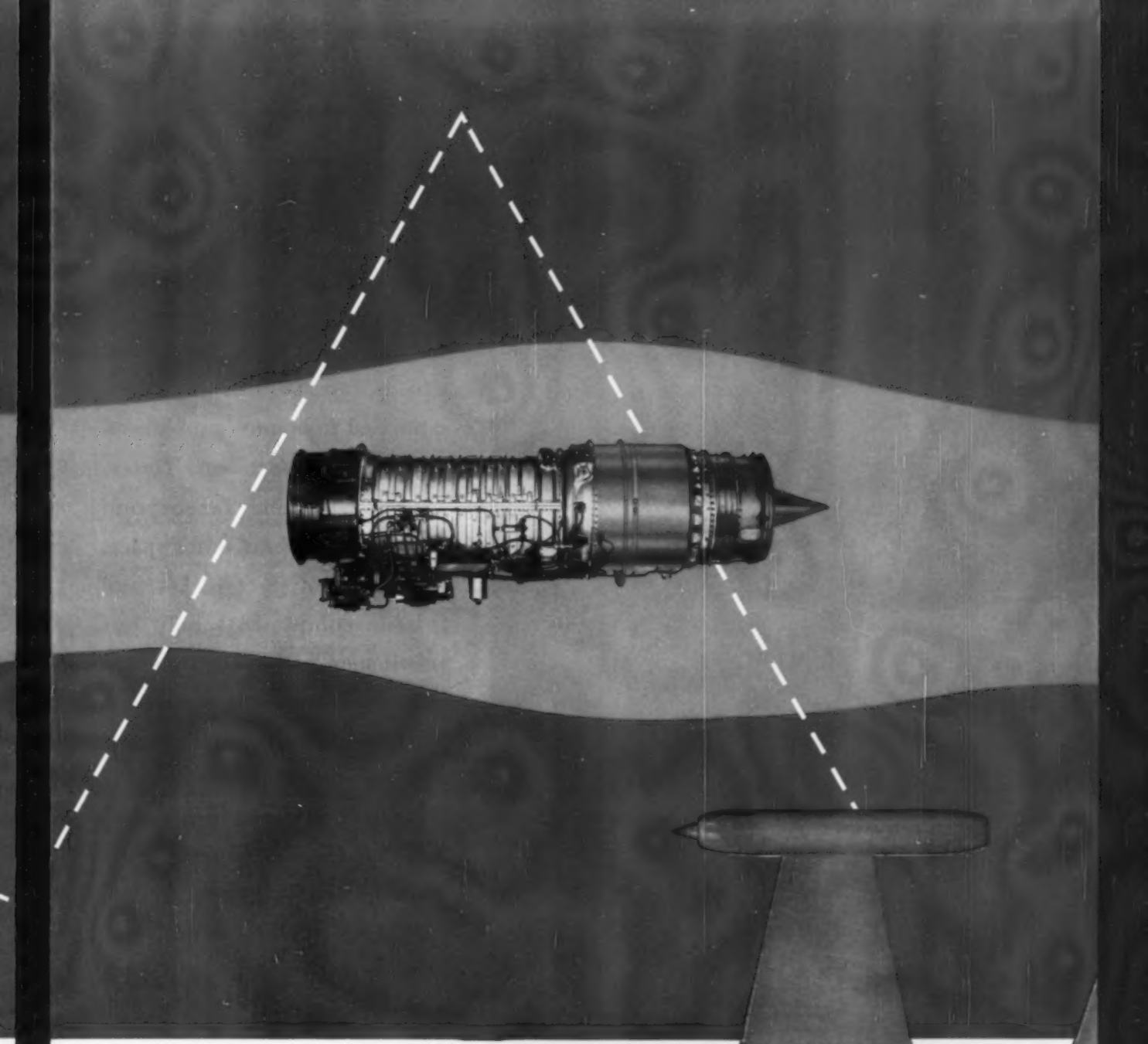
**CRANE CAPABILITY** is demonstrated (above) by pilot Joe Dobronski lifting 75-mm. howitzer weighing 1,750 lb. at approximately 1,500 fpm. Cutway area behind cockpit eases ground loading of bulky loads. Enlarged tail, added since initial tests (AW Aug. 11, p. 24) to improve directional stability and control.

**SWIVELING** exhaust deflectors (above) on each engine are linked to rudder pedals and rudders (right) to ensure positive control even when helicopter is hovering with heavy load in still air. Note linkages atop rudder, on deflector.

# Westinghouse proves jet combustion efficiency

This plastic combustor model enables Westinghouse engineers to predetermine combustion efficiencies in turbojet designs. Observations of the flow of the colored water and air bubble mixture permit visual evaluation of air flow patterns in normally unobservable areas of engines. This test method minimizes trial and error testing with handmade metal prototypes.

Development of the latest J34 configuration for use in North American Aviation's T2J trainer proved the value of this water flow analogy test



rig when design modifications to permit the use of avgas and JP-4 or JP-5 were quickly and accurately evaluated. This is just one of the many complete facilities for research, design, development, testing and production of jet engines at the Aviation Gas Turbine Division, Westinghouse Electric Corporation, Box 288, Kansas City, Missouri. J-54050

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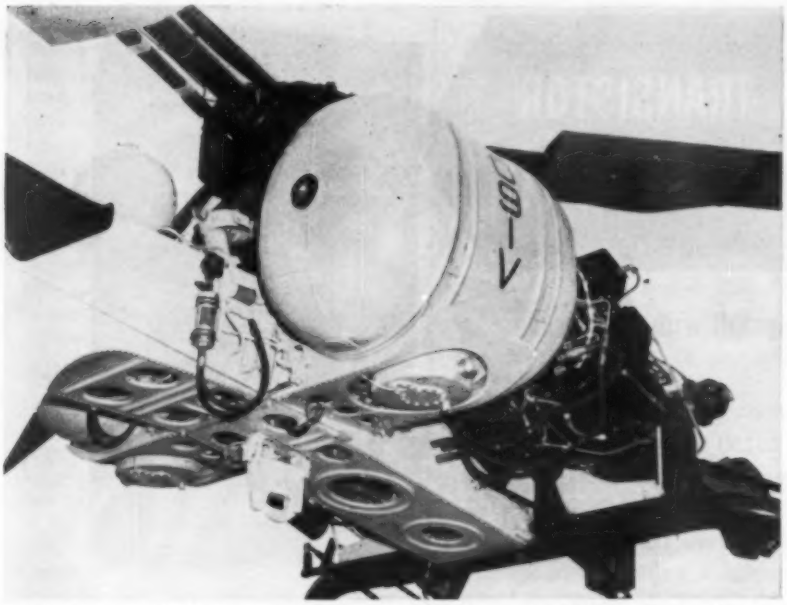

**FUSELAGE** underside, looking rearward, showing 4,500-lb. capacity Eastern Rotorcraft cargo hook, port 100-gal. JP-4 fuel tank and water injection tank (behind rotor head).

Model 120 can carry up to 300 gal.

Project is company financed—so far as McDonnell knows there is no military requirement for such a vehicle. It expects that on the basis of demonstration and evaluation, military may find a requirement for such a vehicle. Army personnel have flown the 120 and, according to McDonnell spokesmen, the crane is ready for off-the-shelf purchase.

Simple, rugged fuselage weighing 171 lb. carries the side-by-side-mounted AiResearch turbine air compressors, whose initial design application was to provide starting for large turbojet engines. Quick-change provisions permit replacement of any powerplant in 5 min. without use of tools, McDonnell engineers point out. Each engine has six quick disconnects, are uncowled for easy access.

Engines supply compressed air, which is ducted to the tip-mounted McDonnell designed burners, engine exhaust is diverted through triple nozzles. Nozzles are mechanically interconnected to the rudders and rudder pedals to provide positive directional control while aircraft is hovering.

Initially the Model 120 was fitted with GTC-85-35 engines, each delivering 128 lb. of air per min. to the rotor, and, with burner nozzles trimmed for hot day, resulting in 630 lb. total thrust. Currently the prototype has improved GTC-85-125 engines, which have cast nozzle boxes, delivering 140 lb. per min. of air each to the rotor, resulting in total power at the tips of 630 lb. thrust. In the works is installation of a still later engine, the GTC-85-36 delivering 145 lb. of air per min. each to the rotor and providing a total power from the burners of 655 lb. thrust.

Engine provides 32-33 lb. thrust per engine through the exhaust nozzles for directional control.

Use of pressure jet system, obviating need for transmission, power shafting and tail rotor, made possible basic crane configuration by permitting large "cut-out" area in the fuselage frame for load carrying.

Rotor system, of the stiff all-metal blade and pitch-cone coupling type, was lifted directly from McDonnell XV-1 convertiplane originally designed for

## McDonnell Model 120

**Basic Weights**

| | |
|---|---|
| Design gross weight | 5,000 lb. |
| Maximum gross weight | 6,300 lb. |
| Empty weight | 2,450 lb. |
| Basic flight weight | 2,705 lb. |
| Pilot | 200 lb. |
| Oil | 45 lb. |
| Trapped fuel and oil | 10 lb. |
| Rotor | 848 lb. |
| Tail | 46 lb. |
| Fuselage | 171 lb. |
| Skid gear | 192 lb. |
| Engine mounts | 28 lb. |
| Flight controls | 87 lb. |
| Powerplants | 866 lb. |
| Instrumentation | 19 lb. |
| Hydraulics | 41 lb. |
| Electric system and battery | 118 lb. |
| Electronics | 15 lb. |
| Furnishings | 19 lb. |


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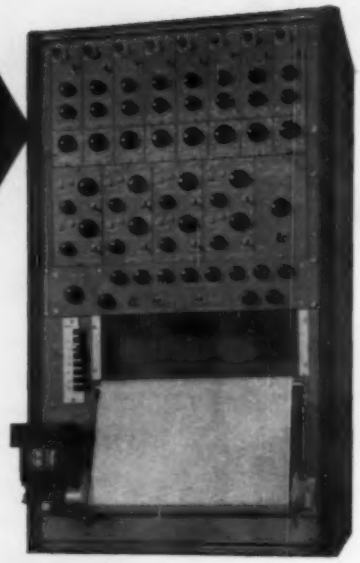

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USAF. Proven reliability of the system, as pointed out by the company, is shown by the fact that in 750 hr. of rotor operation, the blades have never been tracked—company does not even have any blade tracking equipment, one representative told AVIATION WEEK. Rotor layout also has these features: eliminates all bearings, under centrifugal load (there are only 14 bearings in system), eliminates external lubrication requirements and provides inherent anti-icing of the entire rotor system (compressors furnish air at some 350F to tips).

### Hollow Blade

Air is ducted through hollow blade spars to the burners, where simple governors, utilizing flyweight metering, supply fuel for burning. Governor system maintains near-constant rotor speed of 400 rpm.—should there be a restriction of flow to any of the tips, other governors would sense drop-off and strive to maintain sufficient fuel flow to maintain rpm. automatically.

Water injection system sprays directly into engine intake, is capable of providing sufficient boost to maintain standard day performance of 90F day—power increase is equivalent to allowing 600 lb. of additional payload. Water tank, located atop fuselage between fuel tanks, has 5 gal. capacity.

## McDonnell 120 Performance Estimates

Powerplants.....Three AiResearch GTC-85-36 gas turbine air compressors supplying McDonnell rotor tip burners.*

Fuel capacity (JP4).....212 gal.

| Gross weights | 5,000 lb.[1] | 6,300 lb.[2] |
|---|---|---|
| Maximum speed | 138 mph. | 127 mph. |
| Cruise speed | 109 mph. | 106 mph. |
| Maximum rate of climb (SL) | 2,400 fpm. | 1,400 fpm. |
| Vertical rate of climb (SL) | 1,500 fpm. | 300 fpm. |
| Hovering ceiling, in ground effect, NASA standard conditions | 12,000 ft. | 3,500 ft. |
| Hovering ceiling, in ground effect, 95F | 7,500 ft. | 1,000 ft. |
| Hovering ceiling, out of ground effect, NASA standard conditions | 10,000 ft. | 1,700 ft. |
| Hovering ceiling, out of ground effect, 95F | 6,000 ft. | ..... |
| Maximum endurance, SL @ 69 mph. | 1.2 hr. | 1 hr. |
| Range | 98 stat. mi. | 92 stat. mi. |

* Flying prototype now fitted with improved GTC-85-135 engines, further-improved GTC-85-36 to be fitted later.

[1] Gross weight to permit 700-fpm. sea level maximum rate of climb with one engine inoperative. [2] Gross weight to permit 100-fpm. sea level maximum rate of climb with one engine inoperative.

The company reports that the basic simplicity of the aircraft makes rapid pilot indoctrination possible. While demonstrating the Model 120 in the Washington area, McDonnell checked out 13 pilots in two days; on a trip to Quantico, Va., eight pilots were checked out in 2 hr. Engine starting is by means of simple on-off-start switch for each powerplant. Basic fuel is JP4, although gasoline can be used for limited periods of time. Company reports that the pressure jets are insensitive to type of fuel used.

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# Army Helicopter Tests Stress Mobility

**Los Angeles**—Main points of helicopter testing and training being conducted to advance the Army's mobility were outlined by Col. John J. Tolson, assistant commandant, Fort Rucker, Ala., at the Fifth Annual Western Forum of the American Helicopter Society here.

Activities being conducted by this Army facility's Aviation Board include test and investigation of the following:

• **Absolute altimeters**, considered necessary for zero instrument capability and helicopter flight.

• **Proposed installation** of Bendix-Pacific Decca system in a Sikorsky H-34.

• **Development of mirror** system to aid in cargo hookup and release from under H-34, Vertol H-21 and Sikorsky H-37 helicopters.

• **Bell YH-40** gas turbine-powered helicopter. First Army rotary wing craft of its type, the YH-40 has now passed the 200 hr. mark. Aircraft has a Sperry governor which maintains constant rotor and engine rpm. in face of varying power requirements.

• **Automatic stabilization** equipment (ASE). H-34 tests with Lear-Sikorsky ASE were completed last year, and equipment has been recommended for future H-34s. Projected for test are two H-21s with Sperry ASE.

• **Accelerated 1,000 hr. tests** of H-21C and H-24 helicopters conducted by Army Transportation Aircraft Test and Support Activity (TATSA), resulted in a 97% availability record during an 82-day test program which ended Oct. 24. Present Army average is 58%. Army said preliminary test studies indicate service lives of some components may be extended as much as 250 hr.

Facility's aviation school is conducting these activities:

• **Helicopter mobile task force** concept experiments. For more than a year, Army has been conducting experiments in arming of all helicopters in its inventory, excepting the H-37.

Weapons employed have included .20 and .30-cal. machine guns, 2.75 fin stabilized rockets and 20-mm. cannons. Results have been "gratifying." Aviation school is now conducting tests with French Nord SS-10 wire-guided missile (AW April 14, p. 33). Scheduled for use soon are the 4.75 spin-stabilized rockets. About 1,000 of these are available from Army inventory. Aerial Combat Reconnaissance Combat Company has recently been organized.

Currently, all weapons are considered good for "suppressive" firing.

• **Helicopter Instrument** training program. First instrument flying course in this program has just been completed. Course included eight participants; two were Marine Corps personnel.

• **Helicopter Instrument** examiner course. Just beginning, this program will establish instrument flight quality control for Army Aviation. Course started with six participants, is expected to increase to 16 by next February. Equipment in the program now includes three H-21s and three Sikorsky H-19s. Scheduled for early inclusion in program are three H-34s.

• **Flight and maintenance** training on Bell H-40, Army's first gas turbine-powered helicopter program is scheduled to start next spring.

• **Crew flying training.** Work is being conducted with the H-37 and is the first training program of its type in the Army.

Two technical sessions of the forum were devoted to aspects of rotary wing aircraft which had not been featured in past meetings—one on development and test of turbine-powered helicopters, the other on whether high wash velocity will cause operational problems for large helicopters and VTOL aircraft.

A paper on Air Force flight test experience with turbine-powered helicopters by James S. Hayden of Air Force Flight Test Center, Edwards AFB, concluded that although experience with turbine-powered helicopters AFFTC has tested has by and large shown that the machines do quite well, several areas show need for considerable improvement.

Altitude performance at cool temperatures, low installed weight and instant start capability of the turbine are particularly excellent features, Hayden said, but he urged concerted effort by both engine and airframe manufacturers toward:

• **Reducing specific fuel** consumption.

• **Providing satisfactory** hot day performance.

• **Improving governor** operations of free shaft turbines.

• **Reducing power recovery** time delays.

Hayden pointed out that specific fuel consumption is very high for small (less than 300 hp. gas turbines. He also cited the fact that operating turbine engines at partial power yielded higher specific fuel consumption, in comparison with piston engines.

Working with a design limit of hovering at 6,000 ft. on a 95F day results in a fuel consumption penalty, Hayden said. Three methods of resolving the compromises required to achieve hot day hover are derating the engine, allowing the helicopter to be overloaded under favorable atmospheric conditions, and providing power augmentation.

As an illustration of derating, Hayden pointed out that the Lycoming T53 and French Artouste 2B burn their installed

## Ka-15 Enters Red Fleet Service

**Russian Ka-15 coaxial helicopter, now in service with Soviet fleet, lands on the deck of a cruiser. Two-place aircraft recently flew more than 101 mph. over a course 62.76 mi. Ka-15, designed by N. I. Kamov, is powered by 225 hp. engine and has a range of 2½ to 4 hr. at 78 mph. cruise speed (AW June 9, p. 51). Lifting system consists of two three-bladed rotors mounted on single geometric axis.**

weight in fuel approximately every 45 min. at takeoff power at sea level. Assuming a one hour hovering mission at these weights, with a 5,000 lb. gross weight helicopter, the machine is carrying excess engine and fuel equal to about 75% of the weight of the engine required to provide hovering performance at sea level standard conditions.

Allowing the helicopter to be overloaded at sea level standard conditions, it could hover out of ground effect at approximately 7,500 lb. or with a 50% increase in weight.

It is to be realized that the overloaded condition will be reflected in increased structural weight, and an efficient 7,500 lb. machine is not necessarily an efficient 5,000 lb. one. While the machine is used to full capability and performance penalty is less than pure derating, a disadvantage is that operation of an overloaded machine would present problems such as limited planning ability.

Augmentation has the advantage of providing altitude in hot day performance capability without seriously penalizing normal operations performance. Various methods have been suggested such as water injection, interburning, overboost and direct auxiliary power supplied by separate engines.

Any augmentation should not be a part of the basic helicopter, meaning that as much augmentation weight as possible should be removable. This will keep standard day performance penalty at a minimum and will increase operational flexibility of the helicopter.

Of the three methods, augmentation seems the most promising and should be the most favorable from a performance standpoint and the easiest to deal with operationally.

### Turbine Controls

Opinions concerning governing, power response and controls, Hayden said, are the opinions of AFFTC test pilots and engineers based on the center's turbine experience to date.

Experience has shown that governing and powering response of fixed shaft turbines is quite good. Unfortunately, said Hayden, governing of free turbines, as evidenced by ability of the engine governor to maintain a selected rotor rpm., is not quite so good, and power response is marginal in some cases.

The slow power response of the free shaft turbines is one of their more serious weaknesses, particularly in view of the common practice of conducting autorotational landings for training purposes. AFFTC standards Hayden said, require power recovery capabilities such that power increase is from flight idle (or autorotative) to normal rated in 3 sec. This response is available with reciprocating and fixed shaft turbine en-

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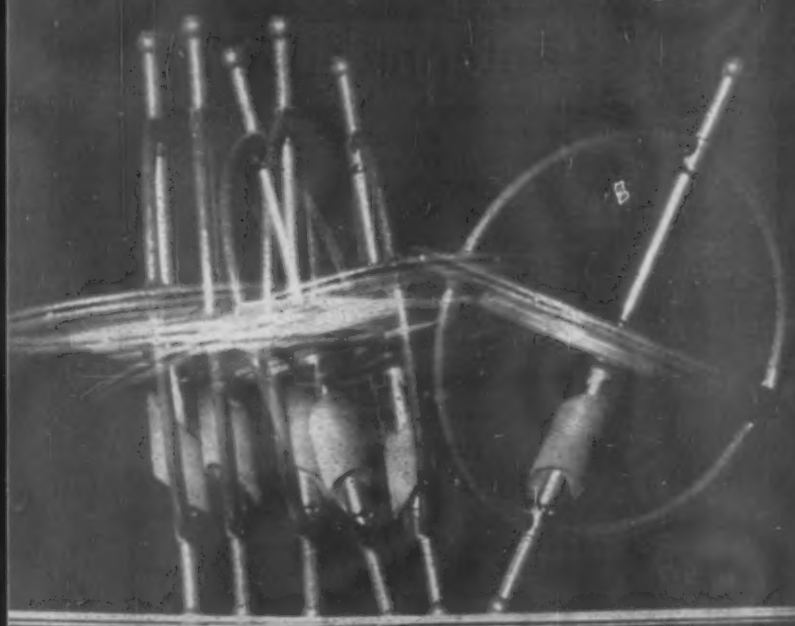

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gines, but is about twice as rapid as the response of free shaft turbines AFFTC has tested.

Regarding controls, Hayden mentioned four:

- **Starter control** should be operated by a three-positioned switch: the depressed position should energize a fully automatic starting cycle to ground idle, intermediate position would be off, the lift position should motor the engine, and the switch should be springloaded from this position.
- **Governor switch** should be a two-position type (normal, emergency) and should be guarded and located on instrument panel or center console.
- **Rotor speed selector** switch should be a trim ("beeping") type switch and should be located on collective pitch control. Also included should be a center console-mounted lever which manually provides coarse selection of desired rotor speed which also provides an indication of rpm. range which has been selected. Lever would essentially be positioned manually or by rotor speed trim switch.
- **Mode selector** should be incorporated in the twist grip and should have the following positions: governed flight, flight idle, ground idle and cutoff. Prominent click-stops at all positions and visual reference marks should be incorporated as should a guard in form of a positive lock from cutoff position.

### Turbine Helicopter Design

Design requirements for turbine powered helicopters were discussed by Martin L. Stevens, Kaman Aircraft Corp., covered such general items as powerplant location, type of mounting and induction systems. Steven's paper went into the point of accessories for turbine helicopters. General standard accessories for helicopter turbines should be located according to engine installation, Stevens noted, adding that a survey of the helicopter industry indicated need for two power takeoff pads—one for hydraulics, one for the generator.

Auxiliary power takeoffs for such special purposes as large generator required by electronics in an anti-submarine warfare helicopter require different solutions, Stevens said. Main transmission is often used for this purpose, Stevens said, but this poses problems when power must be used in ground checkout without rotors turning.

Concerning auxiliary power takeoffs in general, Stevens pointed out that for every horsepower extracted from a gas producer section, up to approximately two horsepower is subtracted from the turbine output shaft, a fact which cannot be ignored when considering auxiliary power extraction during high-power operation of the engine.

Stevens recommended that both en-


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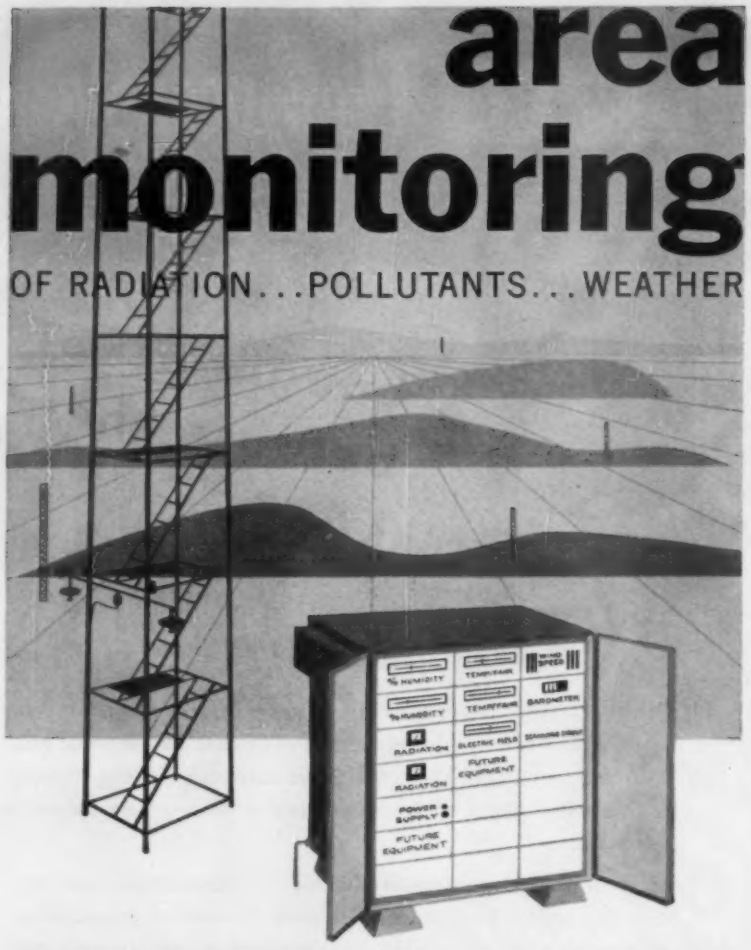


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gine and accessory manufacturers consider the merits of directing more effort toward developing lightweight cold weather starting units, perhaps an electrical starter which could utilize efficiently the high power output of new lightweight batteries.

Rotor brake for a turbine should be relatively large and heavy if the rotor is to be stopped from high rpm. in 15 sec. with gas generator idling; this is a circumstance in which the relative lack of engine idling torque must be considered.

### Turbine Response

According to Stevens, while there has been some concern about transient response of the free turbine helicopter engine as compared with a piston engine, current turbine engines have demonstrated rapid power recovery from flight idle once the fuel is fed to the gas producer. Therefore, Stevens says, if there is any delay in engine response it must occur in the engine fuel and power controls or in the system which controls the setting of the main power lever on the engine.

Transient response of a free turbine during most flight maneuvers used in most current applications is generally reported satisfactory, Stevens says, but he adds that power recovery from flight idle in current turbines is not as rapid as in a piston engine due to acceleration limits of the gas producer. Furthermore, additional delay in response may occur in fuel and power control and/or the system which controls setting of the main power level. Consequently, a high flight idle setting which is contrary to the desired needle splitting requirements may be necessary to ensure a power recovery response rate compatible with sound operational procedure.

R. H. Wheelock, Bell Helicopter Corp., reported on development and flight testing of the XH-40 turbine-powered helicopter, limiting the paper to problems associated with the turbine powerplant installation.

Performance of the Lycoming T53 has been outstanding, Wheelock said, and at no time were test schedules seriously affected by the powerplant, and in view of the state of engine development, this was felt to be significant.

First major problem consisted of divergent torsional oscillation which occurred in early ground runs of the XH-40 in high power range. Investigation showed the fuel controls sensitivity to speed changes was such that it sensed the drive system natural frequency. Test data was gathered on engine drive system frequency and the engine manufacturer designed overlap into a servo fuel valve which desensitized fuel control.

Response of the T53 to power load-

ing changes is a function of acceleration fuel flow schedule. Basic YT53 engine has a 5 sec. response time from flight idle to military rated power. The present T53 engines are yielding 4 sec. acceleration times. Another problem was operation of the emergency fuel system which consists of a manually operated valve which completely bypasses the fuel control unit.

With this system it is possible to induce large step variations in fuel flow; therefore, all safeguards against flameout and compressor stall are removed. Consequently, the switch from normal to emergency must be made with care.

Investigation of the fuel consumption characteristic of the T53 has shown that early engines did not yield desired specific fuel consumption. Better specifics have been realized on the newer T53 although the original predictions are still unattained.

Speaking of areas where problems did not arise, Wheelock said that noise level inside the cabin was materially reduced by turbine engine installation. Effect of jet wake on stability, control or vibration was checked and found to be negligible.

The only problem in jet wake concerned direction so that tail boom skin temperature did not reach unacceptable levels. Also, the skin was changed from magnesium to aluminum.

Reliability of the T53, Wheelock said, has been excellent during various XH-40 test programs. Approximately 1,200 hr. operating time has been accumulated under all types of atmospheric conditions and pilot comments have been favorable.

### Conversion to Turbine

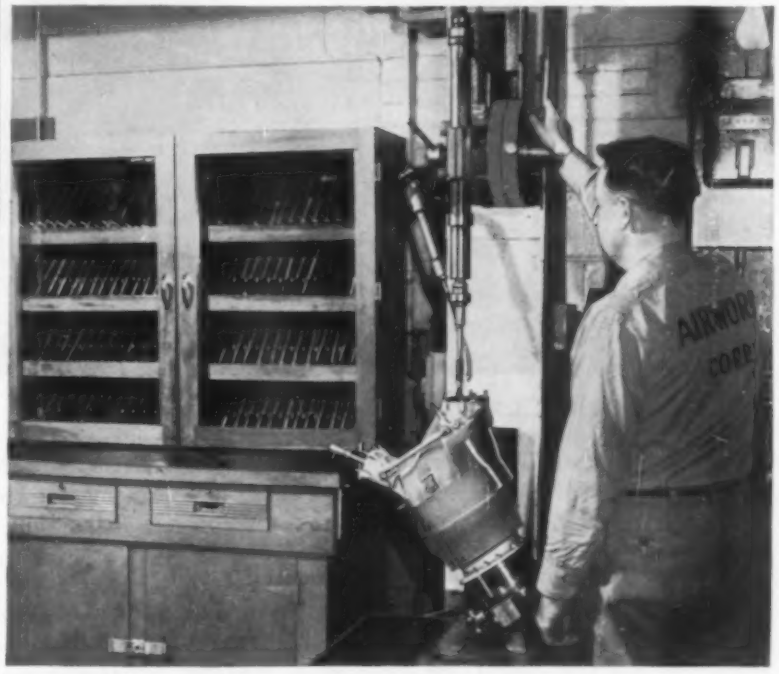
Sikorsky Aircraft Division of United Aircraft Corp., in reporting on turbine power for the S-55 in a paper by Miller A. Wachs, indicated a very successful conversion. By using the tried and proven dynamic components of the S-55, the company materially shortened development time of the aircraft. These components were connected with direct drive to the 20,000 rpm. T58 free turbine engine. Sikorsky used direct drive to get increased efficiency due to reduced number of stages and also got reduced installation weight of transmission gearing. The T58 can be operated with or without reduction gearing as an integral part of the engine.

At various times in helicopter history the desirability of two-speed transmission has been advanced since a lower rpm. is desired for maximum hover capability and a higher one is best for maximum forward speed. This flexibility in rotor rpm. is desired with the possibility of obtaining maximum power at each rpm. and is achieved with the free turbine engine according to Wachs. With the governor controls provided, once the pilot has selected the rotor rpm. he desires, he then can call for power as the occasion demands simply by actuating the collective pitch control. He no longer needs to worry about synchronization. The fuel control system holds the rpm. within very close limits throughout rapid changes in pitch.

Significant reduction in engine and installation weight was achieved, even though the T58 was derated to 671 hp. for the S-62—a specific weight of only 0.4 lb. per hp. By elimination of the clutch, the fan disk and blades, and substitution of much shorter and smaller engine to transmission drive shaft, a 98% weight saving was realized.

Although weight savings were made in other places, Wachs said, there were compromises, especially in transmission extra stage and heavier support, more transmission tooling. Over-all (from the piston S-55 installation) a net weight saving of 1,140.2 lb. was realized.

Concerning specific fuel consumption, Wachs pointed out that both high power and cruise conditions must be considered. He indicated that the best comparison is in performance of a mission. Drawing up a hypothetical mission calling for an 800 lb. payload, a

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# PROVING OUT THE IROQUOIS

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At the Air Force Flight Test Center, Edwards Air Force Base in California, skilled engineering and test pilots are proving out the Army's Iroquois helicopter in Phase 4 performance and stability testing.

This is just one hurdle in the Army-Air Force obstacle course the Iroquois must pass successfully to merit the Army's acceptance. And since the Iroquois, Bell's HU-1A turbine powered helicopter, was designed and built to meet the Army's needs for front-line duty, these tests are hard, tough and realistic.

Phase 4 testing, covering the helicopter's entire flight regime, is conducted to substantiate helicopter stability, handling characteristics and performance data. It will verify the HU-1A's ability to meet the particular weapon system requirement. Instrumentation is used extensively throughout the tests to record data, which is reduced to standard conditions, thus eliminating variables from the test results.

And this is true throughout the complete series of tests . . the Iroquois is *proving* its worth . . in every phase of performance, supply and transport, weather, maintenance, combat conditions and general military usage. Final approval of the Iroquois will mean that the Army, as always, has the finest in fighting equipment.

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100 naut. mi. cruise radius, 6,000 ft. hover capability, and 100 kt. cruise speed, he said the S-55 can meet the payload and radius parameters but only at a speed of 80 kt. and 4,000 ft. hover. The S-62 however, can meet all requirements with performance to spare.

Holding speed, radius and hover altitude, payload could be upped to 930 lb. or holding payload, cruise and hover, radius can be increased to 115 naut. mi., or holding other parameters, hover altitude can be raised to 7,800 ft.

Wachs said that while this indicates progress, there still is much room for improvement. He added that Sikorsky is studying installation of turbines in other models to take advantage of proven dynamic components, indicating that such conversions will take place as suitable powerplants become available.

Two services' problems with downwash on the large and heavy twin-engine Sikorsky S-56(H-37A and HR2S-1) were outlined in paper during the session concerned with this problem. Although downwash problems were of primary interest, other aspects of operations with this machine were detailed.

Both papers, one by Army Aviation Board representative Maj. Willie W. Barrios, other by Lt. Col. A. W. Culley of Marine Corps, indicated that operations over rough or unprepared terrain produced a number of problems.

Primary problem is lack of visibility for the pilot due to dust, flying dirt and grass or other matter. A cloud of dust reduces pilot visibility to an extremely marginal condition, and in case of any aircraft or wind shift which closes off the small remaining visibility emergency takeoff is the only recourse. This of course can be hazardous, especially if loading is in progress.

Other problems accrued to ground crewmen who need more than ordinary protective clothing to work in the downwash area during hookups.

Additionally, debris damage to airframe and engine is significant according to experience of both services, varying to some extent according to measures taken to alleviate the problems. Serious reduction in mission effectiveness had been encountered by both due to clogging air filters in engine induction systems. Some rotor effectivity reduction also was recorded by one service after 50 hr. due to erosion from ground hover debris.

Another problem area was static electricity, with recording of voltages as high as 40,000 reported, although amperage was negligible.

Still, men were knocked to the ground when touching the aircraft as it hovered during a sling or equipment hookup. Means to discharge static are badly needed, both services indicated.


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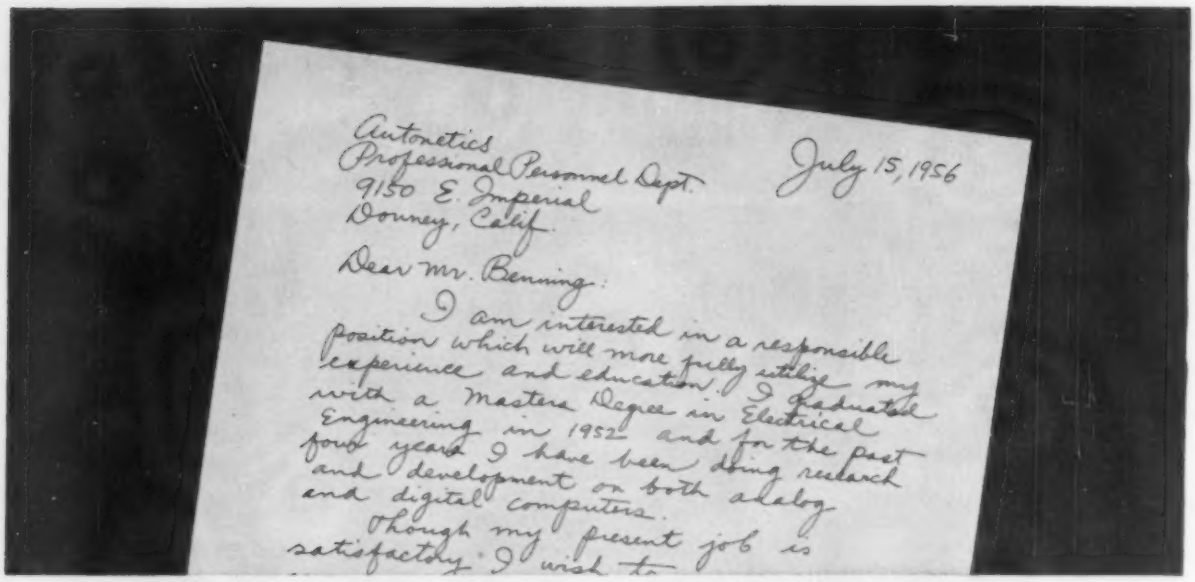
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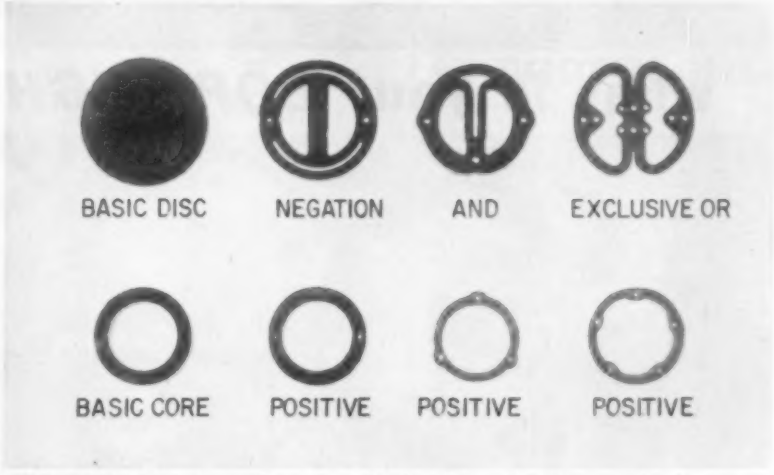
# Ferrite Cores Perform Logic Functions

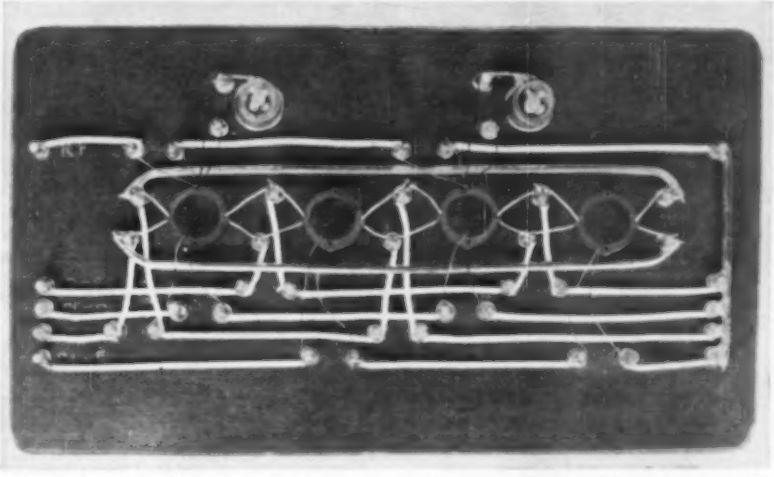
By James A. Fusca

Menlo Park, Calif.—A new and unusual technique for using magnetic cores to perform computer logic functions is being studied by engineers of the Stanford Research Institute under the sponsorship of the Burroughs Corp. Research Center.

Employing toroidal ferrite cores that resemble conventional magnetic cores, the technique varies the core geometry to obtain different logical functions. Because effective decoupling can be obtained between different windings connecting the same element, the cores can be directly interconnected to provide one-way information flow without diodes or similar unilateral devices.




**MULTI-APERTURE** devices under study at Stanford Research Institute employ ferrite cores with varying geometries to obtain logic functions within the individual element.



**SMALL** experimental shift register that uses multi-aperture devices shows the extremely simple interconnection circuitry required for a basic four-pulse clock cycle.

## Special Advantages

Termed multi-aperture devices, these variable geometry cores combine several of the advantages of conventional magnetic cores with some special advantages of their own. Some of the advantages of conventional magnetic devices are:

- **High reliability** and very long life.
- **Potential low cost.**
- **Undamaged by radiation.**
- **Operation over a wide** temperature range.
- **Good stability.**
- **Shape and size of devices** can be varied considerably.
- **Large number of materials** available with a wide range of characteristics.

Advantages claimed for the multi-aperture devices are:

- **Use magnetic paths** or geometry of the devices to perform circuit functions.
- **Very low impedance** circuits easily coupled to transistors and indicating devices.
- **Only the magnetic cores** and connecting wire are required for complete circuits, except for driving units.
- **Cores require** only a single turn of wire for operation.
- **Circuit versatility** results from complete decoupling of all inputs and outputs.

## Shift Registers

At present the laboratory is studying the use of multi-aperture devices in shift registers—which are said to be nearing commercial feasibility—and the interconnection of large numbers of the devices for performing complex logical functions. Laboratory models have indicated operating speeds as high as 250,000 pulses per second over a temperature range from −50 to 100C.

Conventional toroidal magnetic cores exhibit properties that make them well suited for such applications as digital storage. For logic operations, however, their bilateral properties make it necessary to add unilateral elements such as diodes in any coupling or transfer loop connecting them.

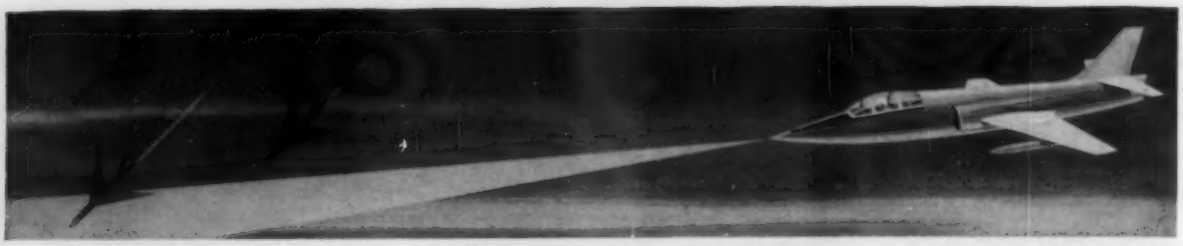
A laboratory engineering team composed of H. D. Crane, Dr. D. R. Bennion and F. C. Heinzmann at Stanford Research Institute has found that by varying the geometrical shape of basic toroidal cores, multi-aperture or multi-path logic devices can be designed which can be connected with wire.

These devices can have any desired number of inputs and outputs, with any input reading information into the element without crosstalk to other information windings.

Also, the information can be successively read out of one or all of the outputs without the readout from one output affecting the information state at any other output.

For example: one of the output apertures may be used to connect an indicator to display the binary state of the element.

Logic functions may be formed directly within the elements or the ele-



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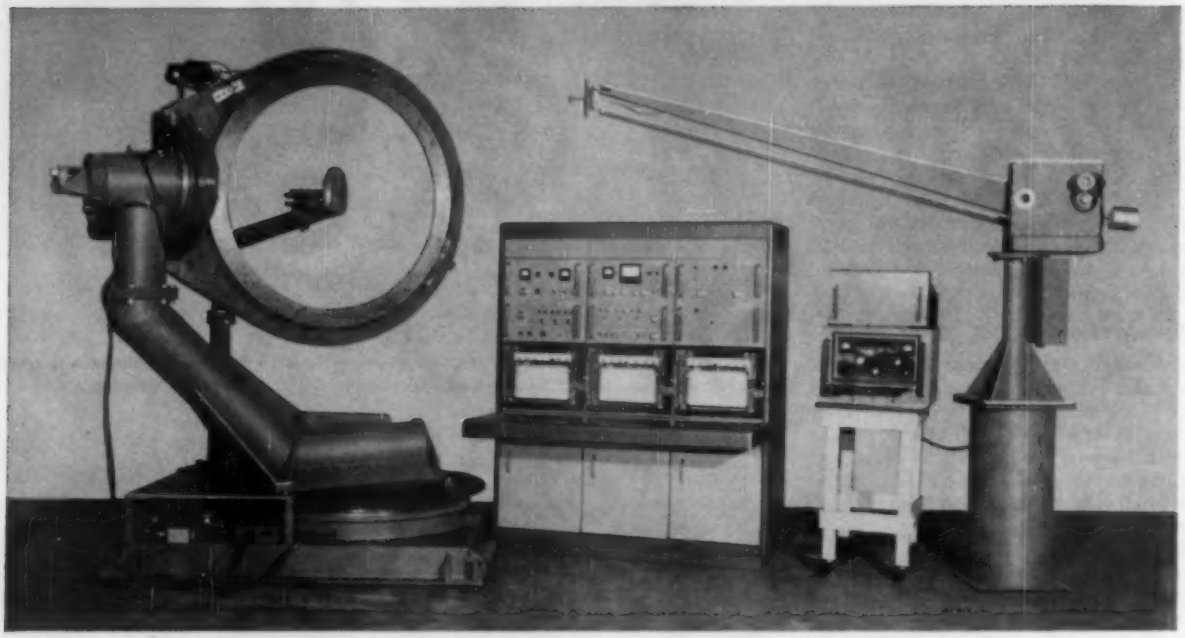

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Additional features include automatic plotting of antenna patterns with or without the radome and radome transmission efficiency measurements. The system is available in frequencies from S through $K_a$ bands and infrared.

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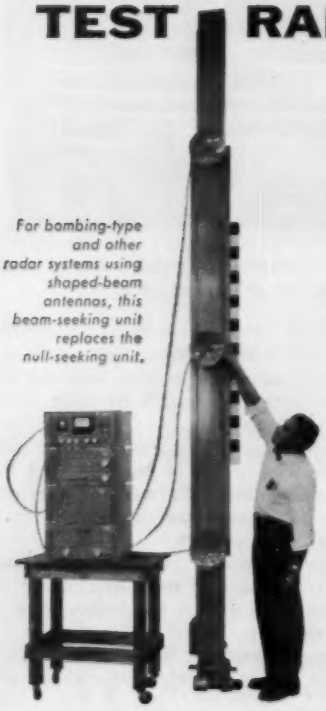

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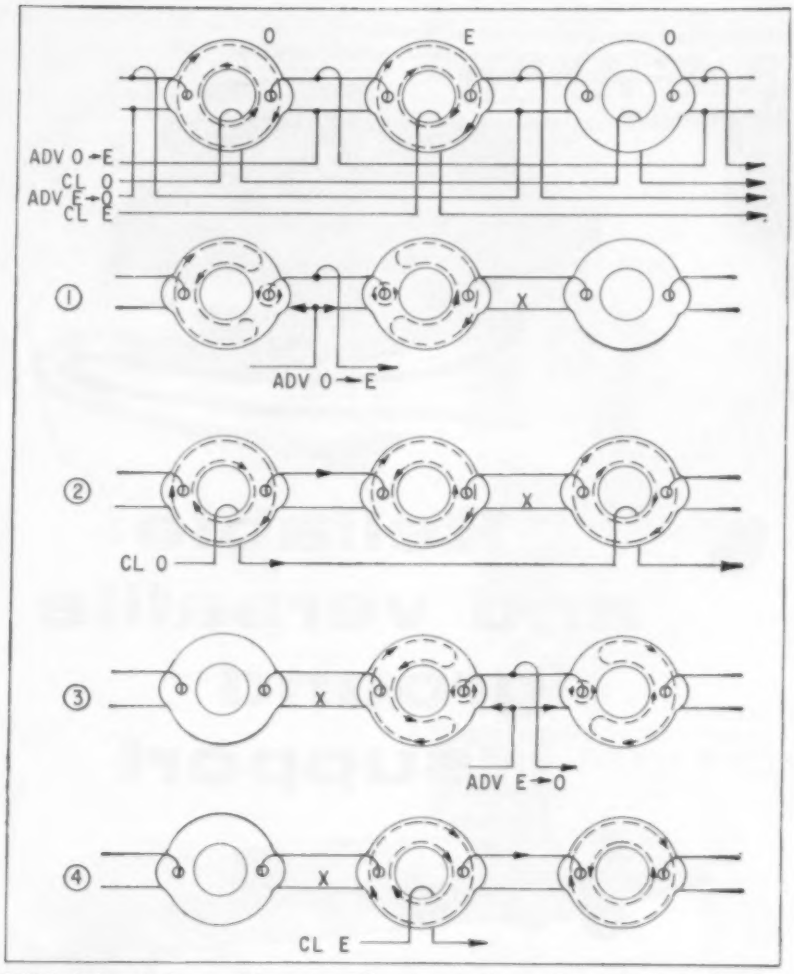


**BASIC** clock cycle for a multi-aperture shift register is diagramed to indicate the flux state in each of the cores as the four pulses of the cycle cause the flux to be switched. Multi-aperture elements eliminate the need for diodes used with conventional magnetic cores.

ments can be interconnected to perform the functions. One element, given the inputs *X*, *Y*, can provide as outputs *X* and *Y*, *X* or *Y*, *not X*, *not Y*, and others. Several outputs may be interconnected so as to transfer logical combinations of variables, and each of the elements can be individually cleared.

To understand the properties of these apertures as input and output access-points, consider the basic element structure to be a toroidal ferrite core with the apertures cut in the wall. The distinction between input and output apertures is made in the way that the windings linking these apertures are connected into the system.

The accompanying schematic diagram of a basic clock cycle employing multi-aperture devices indicates their method of operation. Storage and transfer of information is based on a binary code where one state of magnetic flux symbolizes a zero while a second state signifies a one.

The reference or zero state for one of these devices is termed the "clear" state. The "clear" state is generated when sufficient current is passed through a loop of wire surrounding the core so that the total magnetic flux in the core is oriented (in this example) in a clockwise direction.

The binary one or "set" state is achieved by passing a current through the loop connecting the input aperture so that magnetomotive force tends to switch the flux in a counter-clockwise sense with the result that in the "set" state there is a reversal of flux between the inner and outer sections of the core.

An element in the "clear" state is defined as being in the binary zero state. An element in the "set" state is defined as being in the binary one state.

The input aperture provides another extremely important property other than the digital setting feature. In an ordinary magnetic core, a negative magnetomotive force following a positive


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magnetomotive force tends to reverse, symmetrically, any flux switched by the positive signal. In the multi-aperture device, a subsequent negative current applied at the input aperture merely reverses the flux locally about the input aperture without affecting the flux state at the output aperture. This decoupling feature is important in the logic of the basic transfer loop.

With reference to the diagram, the output of the first element is in the binary one or "set" state. The action of transferring this value to the next element requires an order in the form of an "advance" pulse. If the output were in the zero state, nothing would happen and a "zero" would be transferred by default. However, because the output is set and the sense of the inner and outer rings of flux differ, the flux about the output aperture switches locally with very little current thereby forcing the majority of the current to flow through the input aperture of the following element causing it to go over its setting threshold and become "set." As the flux switching is completed, both currents return to their nominal equal value.

### Clock Cycle

To demonstrate the operation of the multi-aperture device shift register, compare it with a conventional two-core-per-bit register. The elements of a conventional register can be divided arbitrarily into two groups, with an "advance" line linking each core of group in series. In this case the object is to shift the stored information from one group of cores to the other each time there is an "advance" pulse.

Using the conventional definition of zero and one as before, transmission of a zero is by default since the "advance" pulse causes no flux switching in a zero output core. However, the "advance" pulse will switch a core storing a one which results in a transfer loop current that switches or "sets" the following core.

Ideally, no effects of this transmission should be felt in any other elements.

To isolate the transmission effects, conventional registers generally employ a series diode to prevent current from flowing in the following loop as a result of the switching of the input of the core being "set," and a shunt diode is used to prevent backward transmission from the core transmitting the signal to the previous core. In this manner, one-way transmission is obtained by the use of unilateral elements.

Actually, each "advance" pulse has two functions. For example, an "advance" pulse ordering the information stored in one group of cores to be advanced to the second group also leaves the group transferring the information


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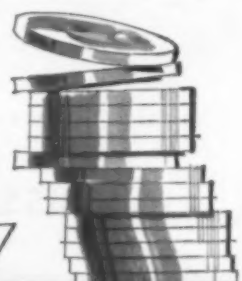

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in the "clear" state, ready to receive new information.

Because reading out the information present at an output aperture of a multi-aperture element does not destroy the information state of the element, the "advance" pulse cannot simultaneously advance the stored information and clear the transmitter as in the conventional core-diode register. Therefore, as shown in the diagram, a register made up of multi-aperture elements requires specific "clear" windings, which results in the basic four-clock system shown.

### Data Transfer

In the diagram, the two groups of multi-aperture elements are labeled odd (O) and even (E) and the information to be transferred is stored in the O cores. The "advance" pulse (ADV O to E) shifts the information to the E elements. The O elements are then explicitly cleared by the "clear" pulse (CL O). The ADV E to O pulse shifts the information back to the O elements, and the E elements are then cleared by the CL E signal.

By tracing the details of the data transmission, it is possible to see how the multi-aperture elements and the basic clock cycle work together to yield one-way transmission. The diagram indicates the transfer of a binary state one while, as stated above, the transfer of a zero is by default.

The diagram arrows indicate the flux switched in any leg of the cores as a result of a particular pulse. The ADV O to E pulse switches flux locally about the output aperture of the O element and causes the E element to become set. The CL O pulse then clears the O element and in so doing switches flux through the output winding. This results in a loop current flow that "negatively sets" the E element without affecting the flux state about the output aperture of the E element.

Note that neither the ADV O to E nor CL O pulses cause any flux to be switched in the output leg of the E element (indicated by the crosses opposite the output winding), eliminating the need for the conventional series diode. The order to advance E to O shifts the binary one to the next O element in the direction of transmission, and the CL E order then clears the E element.

Again, neither the ADV E to O nor the CL E pulses cause any flux to be switched in the input winding of the E element, eliminating the need for a shunt diode to eliminate backward transmission.

Because during the cycle there is no "unwanted" flux that must be dissipated slowly in resistance, the transfer rates may be relatively high. For example: using General Ceramics S-3 or

Telemeter Magnetics T-5 ferrite material, information rates of a quarter megacycle can be achieved—which means a four-pulse cycle time of four microseconds.

Ordinary toroidal cores with small apertures added do not have the optimum geometry for simple shift register elements. The main disadvantages are in the switched flux vs. magnetomotive force relationships and switching properties. The major difficulty is that with apertures cut in the wall, no matter how hard the device is cleared, not all of the material can be left in saturation. This results in remnant reverse domains and hence "minor loop" operation in parts of the core.

### Properties Improved

Both of these properties are significantly improved in the two positive element designs at the right of the accompanying element display photograph which have approximately equal cross-sectional area everywhere. This first order improvement in shaping yields an element that can be almost completely saturated in its "clear" state, with a minimum of remnant reverse domains.

Also shown is the basic "negation" device with a single input and output. As far as the input aperture is concerned, it is only necessary that in the "clear" state the flux in the legs adjacent to the input aperture be parallel so that the element is settable. In this condition, any flux switched in the input will switch through connecting geometry to the output region.

If the flux were originally "anti-parallel" then any flux switched in the input leg would switch locally about the input aperture without affecting the output region. This "clear" state flux requirement holds for all input apertures of all devices to operate within this system. For a "negation" device the "clear" state output aperture requirement is that the flux in the legs adjacent to the output aperture should be anti-parallel. Under these conditions, with no input a binary one will be transmitted.

The extra central leg is provided only for flux-closure properties, and it is prevented from having any flux switched in it by a "hold" winding energized either continuously or at the appropriate pulse times.

With the negation device in its "clear" state, the output "advance" current pulse will cause a binary one to be transmitted to the next element. If previously, the negation element were "set" (had received a one), then the input flux would have blocked the output, resulting in a subsequent transmission of a zero.

The accurately placed slots in the negation element are for the purpose

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# THE VIGILANTE STORY

## A report on the Navy's new manned weapon system, designed to ride herd on brushfire wars... or deter an all-out conflict

Recent events have made it clear that our defense must be built to handle limited warfare as well as full-scale nuclear conflict. The Navy's new carrier-based A3J Vigilante was designed and built by the Columbus Division of North American Aviation to fill this dual role.

### HIGH OR LOW

The twin-jet Vigilante is the fastest and highest-flying of the Navy's attack planes. It can fly in the high stratosphere faster than the earth turns beneath it. But apart from being one of the fastest airplanes in the world, Vigilante also handles beautifully at any height and any speed, right down to slow landing approaches for carrier decks or short runways ashore. This is made possible by its advanced boundary layer control system and full-span controllable leading edge.

### EYES AND BRAINS

Vigilante can find targets at extended strike ranges, even if they are obscured by the weather. The electromechanical system that gives Vigilante this super-accuracy is the result of a coordinated effort between the Columbus Division and North American's Autonetics Division in Downey, California. This precision bombing-navigation system enables the Vigilante to deliver its weapons from any attitude, at any altitude.

**ARMED TO THE TEETH**

Another reason for Vigilante's versatility is that it was designed to handle the gamut of armament, including nuclear weapons. But by far the most important "equipment" aboard is the Vigilante's crew of two—pilot and bombardier-navigator. This is especially true in limited warfare. For only a man can size up a situation... only a man can change his mind if the need arises... only a man can take advantage of an opportunity.

The A3J Vigilante is now in flight test preparatory to joining the fleet.

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of eliminating unsaturated regions about the output aperture present in unslotted cores, so that in the "clear" state essentially all material is on a major hysteresis loop, thereby providing a significant improvement in threshold properties of the device.

### Proper Shaping

From work performed to date, it is clear that by selecting proper shaping, interesting logical functions can be performed directly within the element. These techniques can be extended to more complicated functions such as "and" or "exclusive or." However, in designing such elements, the geometrical aspects of both the logical functions and operational properties must be carefully considered.

Most of the laboratory's efforts thus far have been in developing basic circuit arrangements and understanding the fundamental processes. Although the circuits and elements described have been operated in closed loop stable fashion, no large scale general logic systems have yet been constructed. These new devices and techniques, however, present interesting possibilities for general application in the digital processing field.

# Space Avionics, Propagation Data Dominate Aero-Com Conference

**Utica, N. Y.**—Problems of space communications and related propagation phenomena affecting military and scientific projects presently under consideration were discussed in technical presentations here at the Fourth National Aero-Com Symposium.

Notable by their absence were papers discussing startling new ideas or techniques and—at the other end of the spectrum—blue sky proposals with little relationship to present or anticipated avionic projects.

Among the papers of interest were:

• **Space communications design.** An introduction to space communications system design was presented by L. P. Yeh of Westinghouse Electric Corp. who pointed out some of the unique problems of communicating from earth to space, space to space, and space to earth. Also discussed were repeater satellites and use of the moon as a passive repeater.

• **Polar problems.** Transmission factors affecting communication between space vehicles and polar locations were discussed by Lt. W. D. Stuart and L. C. Kelley of the Army Signal Radio Propagation Agency. The authors pointed out that the VHF and UHF bands seem less dependable and useful from polar sites than elsewhere because of multipathing from the aurora that severely handicaps radio location and is damaging to Doppler measurements.

• **Hypersonic re-entry.** Problems of communication during hypersonic re-entry and a discussion of both optical and radio modulation schemes that might be used were presented by Dr. E. Langberg of Avco Manufacturing Corp. Conclusion of the report was that re-entry communications is essentially limited to two spectral regions, and millimeter wavelength range and the optical-infrared range.

• **Arctic VHF.** Sporadic E anomalies in the Arctic area show a distinct geographical distribution that is extremely important in planning communications links within the region and between there and the U.S., according to R. Penndorf and S. Coroniti, Avco Manufacturing Corp., who discussed propagation of VHF in the Arctic. These sporadic E anomalies were found to be of three types: the Thule type, the Auroral Belt type, and a third type that mixed both of the other two.

In his paper, Yeh pointed out that over most of the electromagnetic spectrum the earth's atmosphere is opaque. The most important window occurs in the three decades between about 3 cm. (10,000 mc.) and 10 meters (30 mc.). At the present state of the art, he said, it seems that only line of sight transmission is feasible.

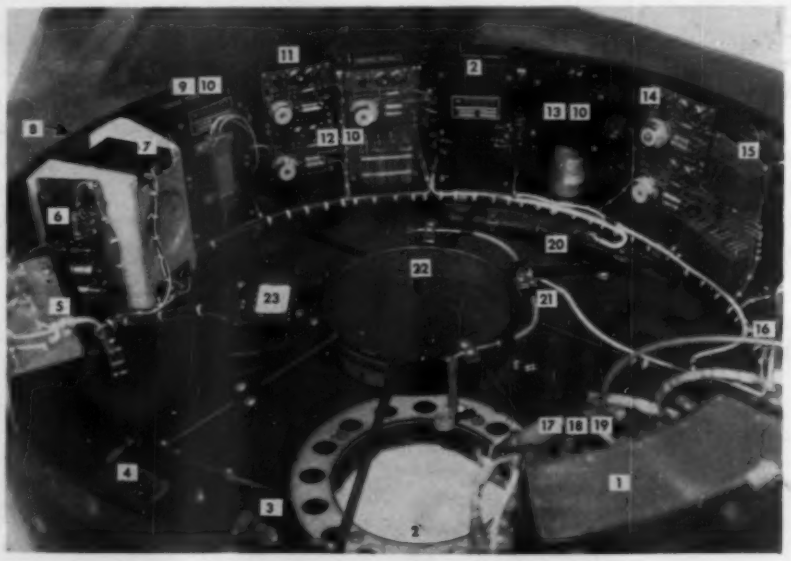
Over the band of frequencies considered feasible for space communications, the thermal noise of the receiver would be predominant at the isolated locations most likely to be used. Therefore, the operational "threshold" of the system could be expected to be determined by the usable carrier to thermal noise power ratio.

The minimum usable carrier to noise power ratio depends on the modulation techniques used.

An average acceptable figure, however, for practical system design would be a value of 15 db.

Satellite observations and moon reflection studies have indicated two types of fading. One, with a period of seconds, is believed to be due to the moon's vibration in the case of moon echoes and to spinning of the satellite in the case of satellite observations. The second type, with a period of about one hour, is believed due to the Faraday effect—rotation of the plane of polarization of a plane-polarized wave as a result of the effect of the earth's magnetic field.

Other effects such as atmospheric re-




**Pioneer Instrumentation**

**Instrumentation package of the Pioneer lunar probe launched Oct. 11 (AW Oct. 20, p. 32) contained the following: 1—Doppler command receiver; 2—removable extra-life telemetry battery; 3—TV final amplifier; 4—TV d.c.-to-d.c. converter and television modulator; 5—TV battery pack and terminal board; 6—TV driver; 7—TV optical unit; 8—TV scanning window; 9—Micrometeorite amplifier; 10—Telemetry battery; 11—Diaphragm for micrometeorite microphone; 12—Micrometeorite sub-carrier oscillators; 13—Magnetometer amplifier; 14—Magnetometer sub-carrier oscillators; 15—Low-pass filters; 16—Compartment-temperature sub-carrier oscillator; 17—Multiplexer; 18—Telemetry transmitter; 19—Diplexer; 20—Magnetometer sensor coil; 21—Connection for telemetry antenna; 22—Damper ring; 23—Backup timer.**

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fraction in both the troposphere and the ionosphere and the lobe structure of the signal due to multi-path transmission may also contribute to fading of the received signal. Fading, therefore, can be considered to be a combination of many effects.

In general, a fading margin of 10-20 db. or more should be allowed for a workable system based on presently available, rather sketchy data. Extensive signal measurements on a long term basis are required to determine the more reliable fading characteristics.

### Moon Relay

A communications system based on use of the moon as a passive relay is feasible for stations on earth at present, if not too high a signal to noise ratio is required. The U. S. Navy is installing a Washington-to-Hawaii teletype link at this time using the moon as a passive relay (AW May 12, p. 32).

For design of a system using the moon as a passive relay, a circuit loss of 250 db. between an isotropic radiator and collector for 100 mc., with a 6 db. increase of loss per octave of frequency may be used. This figure also is derived from the data obtained in moon echo experiments.

A sphere with a diameter of 200 in. (17 ft.) at a 300 mi. height would be required to have the same effect as a reflecting body as the moon at 240,000 mi. height. To put a number of 17 ft. spheres in orbit appears possible in the not too distant future.

In earth-satellite-earth relay systems, the number of satellites required depends on the distance between the earth stations and also on the height of the satellites above the earth (AW Oct. 20, p. 85). The minimum number of satellites required is three, which is set by the geometry and the minimum height of the satellites by the drag of the atmosphere.

The drag would take energy from the orbit and cause the satellite to spiral into re-entry.

# Simulation Facilitates Integrating Bomarc Control Into Sage System

**Dallas**—Simulation designed to give a better understanding of the problems of integrating Bomarc control into the Sage system was discussed here by D. W. Ladd and E. W. Wolf of Lincoln Laboratory at the National Simulation Conference of the Institute of Radio Engineers.

Simulation was to create a design tool for optimizing the parameters of the Sage computer program with respect to Bomarc and to evaluate the performance of this program in a realistic external environment under a wide variety of conditions.

Series of computer programs called Snort (Sage non-real-time) was prepared which simulated automatic Sage functions related to target and missile tracing and missile guidance, as well as the external environment of targets, radars and missiles.

Researchers wanted to get data not only on individual intercepts, but on system performance under mutually interacting intercepts. So Snort has a capacity for 150 tracks and 75 simultaneous intercepts.

Snort is composed of four major components—radar data generation, target tracking, weapons guidance and tracking package (WGT), and data reduction.

Each requires a separate pass in the IBM 704 computer, and there is no feedback between them.

Radar data generation program generates range and azimuth information for a maximum of 150 tracks and four radar sites, and the output is a magnetic tape with simulated radar returns and true target positions. This tape is the input to the target tracking program which does the automatic functions of Sage—conversion of raw radar data to tracked positions and velocities.

From this program come two tapes which can be provided simultaneously. One is the target tape and provides data for the weapons guidance and tracking package. The other is the recording tape and is used for tracking analysis.

The weapons guidance and tracking package carried out missile program, computing time of launch and generating midcourse commands which the missile model uses along with aerodynamic equations to generate positions and velocities. Missile tracking program is analogous to target tracking program and generates tracked missile positions and velocities. This missile track information is fed back to the guidance program.

In the final phase of intercept, Snort simulated the closed loop control system between target and missile. Pertinent data was recorded on an intercept tape.

Input to the data reduction program is either a recording tape or an intercept tape. This program computes frequency distribution and such other data of interest as target tracking error and intercept miss distance. Outputs are the end result of a complete Snort run.

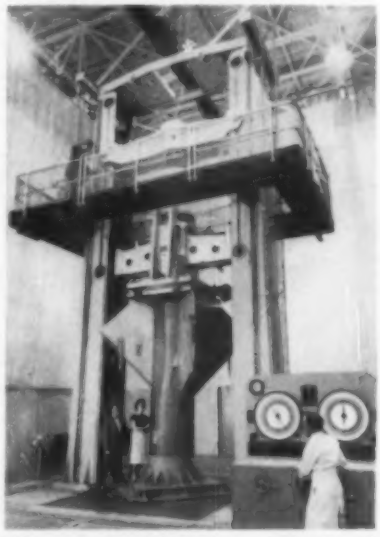
Technique for reducing the number of runs involved in evaluating system performance by simulation was described by W. J. Nemerever of Boeing Airplane Co. The job of evaluating complex systems like Sage can develop requirements for very large numbers of runs in the process.

Nemerever said the technique consists in considering the totality of operating conditions as a totality rather than an amorphous conglomerate to be subjected to further analysis. He said the new method, which is in use by Boeing, can reduce the total number of simulations required to produce an answer by an order of magnitude.

### Battle Simulation

Combined analog-digital simulation of an air battle between an intruding bomber and a ground controlled interceptor was described by A. B. Pritsker, R. C. van Buskirk and J. W. Wetherbee of Battelle Memorial Institute. Simulation was designed to evaluate the effects of airborne electronic countermeasures on a ground based radar operator. It was hypothesized that probability of survival of the bomber would be a better measure of the effectiveness of ECM than evaluations of its effect solely on radar equipment and operator performance.

In the simulation, an attacking bomber generates ECM against an aircraft control and warning site which includes one radar indicator and its oper-



**Bomarc Section Tested**

**Hydraulic test machine applies 100,000 lb. compressive loads on the aft section of a Boeing Bomarc missile. The 90-ton machine, built for Boeing Airplane Co. by the Baldwin-Lima-Hamilton Corp., is rated at a maximum capacity of 1,200,000 lb. Machine can apply tension, compression, flexure and combined loads. A 5,750 kva. power sources provides heat for structure tests at elevated temperatures.**

ator. Operator tracks the bomber through successive positions and headings and directs an interceptor against it.

Radar return of the attacking bomber, ECM signals and the various parts of the radar detection process are simulated with a modified QRC-10(T) ECM simulator. Simulated radar signals provide a PPI display. While tracking the target, the operator calls position and heading of the bomber to a keypunch operator for recording on an IBM punched card. True bomber position data and time are recorded on the same card, and a set of these cards completely describes the target's true and observed tracks. Experiment was conducted for 22 min., the maximum allowable bomber penetration time.

Simulation is carried out in real time and is entirely analog up to the keypunch step, except for conversion to digital form for storage on the cards. The cards then become the input to a digital computer. A digital computer program has been written to simulate an aircraft controller directing an interceptor and to simulate the final phase of the battle between interceptor and bomber. Probability of bomber survival is then computed and is used as a measure of ECM effectiveness.

Transistorized general purpose d.c. analog computer is being built by Autonetics Division of North American Aviation for airborne use. Computer will be delivered next June for use by the National Aeronautics and Space Administration at Langley Field, Va.

Computer will be used initially in an F-101 for research in armament control, flight control and guidance of air and space vehicles. It was described by H. L. Ehlers of Autonetics.

Transistorized computer has an advantage over vacuum tube types in reliability, weight, volume and power requirements, according to Ehlers, and this makes it particularly suitable for airborne use. Initial cost is higher for the transistor design, but Ehlers said this disadvantage is expected to diminish through continued development of solid state devices.

Preliminary studies indicate that the computing components in the Autonetics system will be contained in six major packages, with computer power and reference supplies in a seventh package. Other major units include an oscillograph recorder, tape recorder, tape recorder electronics, overload and event recorder, pilot's display electronics and pilot's display. Total system will occupy 21.1 cu. ft. and weight 885 lb.

Equipment is designed to operate in an unpressurized area where maximum compartment temperature is estimated to be 55C. No air conditioning is provided, but air channels to package heat sinks are in the design, and a fan will provide air circulation.

Computer has 112 operational amplifiers, and other miniature computing equipment in the system includes a general purpose electromechanical servo, diode function generator, wide bandwidth electronic multiplier, electronic timer, miniature patch board, overload and event recorder, and function relays. To reduce maintenance work time on the system, special ground test equipment is under development.

### Interference Effects

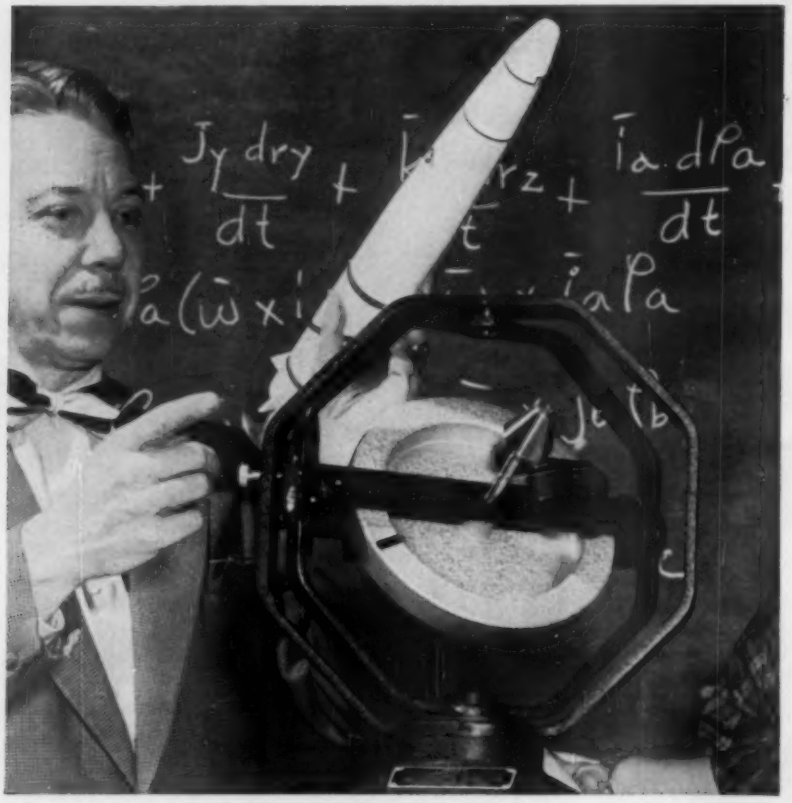
Effects of interference on airborne monitoring of air traffic with radar-beacon systems was studied in a paper by S. J. Neshyba and R. R. Coffman of Convair-Ft. Worth. Their problem was to determine the quantity of interference and quality of system performance in a group of aircraft equipped with radar-beacon systems. Seven aircraft were put into the test group.

To solve the problem, a simulator was built which consisted of a viewing and recording radar component, a component functioning as a set of unsynchronized interrogating radar and a component functioning as a set of beacon transponders. A PPI indictor from a standard radar displayed the air traffic and the system interference, and the display was photographed.

As a result of the simulation, it was concluded that throughout the programmed interference, the radar operator could maintain visual contact with the beacon reply and could interpret the beacon code under all but the most severe interference conditions.

Edward G. Schwarm reviewed the development of computer systems for jet transport simulators and said that novel techniques developed to improve the dynamic response of analog computers in the simulators will gain acceptance in other fields of simulation as they become known.

Schwarm pointed out that the Link DC-8 simulator was built and installed before the first flight of the aircraft and that test crews were able to gain experience before the first test flight. He also observed that development of the analog computer to its present state in flight simulators makes it possible to use the simulators as an engineering tool to test new equipment, including major configuration changes under accurately controlled conditions.



## Gyro Demonstrator

**Large motor-driven gyroscope, called "MITAC", for demonstrating gyro principles, can be operated as single or two-degree of freedom, rate or integrating gyro. Rotor, driven by 115 v. 60 cps. motor, operates at 150 rpm. Complete demonstration kit, including instruction manual containing gyro theory, problems and suggested demonstrations, can be purchased for $235 from AC Spark Plug Division of General Motors Co., Flint, Mich.**

**HIGH SPEED TELEPRINTER,** developed for the U.S. Army Signal Research and Development Laboratory by Burroughs Corp., is capable of operating at a speed of 3,000 words per minute. Machine is shown here with the cover raised and printing head exposed.

# Teletypewriter Has Capability Of 3,000 Words per Minute

**New York**—Teletypewriter said to be capable of operating at a speed of 3,000 words per minute, and with a theoretical top speed of 500,000 words per minute, has been developed by the Burroughs Corp., Paoli, Pa., and the U.S. Army Signal Research and Development Laboratory, Fort Monmouth, N. J. At its theoretical top speed, the teleprinter would type the equivalent of three complete novels in a minute.

### New Network

The Signal Corps will use the equipment as part of a new 750 wpm. military teletypewriter network mated with such units as high speed tape printers and readers, where it is capable of replacing eight present military printers. Among other uses, the high speed printing technique is being applied to the problem of reading out data from military battlefield computers such as Mobidic which produce information at a faster rate than can be handled by conventional page printers.

Prototype machine is a page-receiving, keyboard-sending electronic teleprinter, operating on the standard Baudot start-stop code, capable of two-way operation. Print-out is by an electrostatic recording technique on special paper.

Line width is 72 characters with five lines to the inch. To obtain the extremely high printing speed, 72 matrices are placed in a row to form one printing line.

Each matrix is made up of 35 electrostatic leads, seven leads high by five wide, which in different combinations can make up any letter or number.

The matrices create latent images of the letters to be printed in the form of electrostatically charged areas on the high-resistivity surface of a specially coated paper.

These images are made visible by application of powdered ink which is permanently fixed by passing the paper over a heated roller.

The electronic circuitry of the machine selectively charges the desired combination of the 35 leads in each matrix so that the letter to be printed appears on all 72 matrices. A coincidence pulse is then sent to the back plate or "anvil" on the other side of the paper behind the matrix selected to print.

Deposit of the electrostatic charge requires only about one microsecond.

By sending the letters to be printed serially to all matrices or printing heads and stepping the coincidence pulse sequentially to each printing head across the line, the printing operation is made entirely electronic with the exception of paper transport.

### Technique Highlights

Features of the technique stressed by Signal Corps and Burroughs officials are:

- **High speed.** Primary limitation to the printing speed of the machine is the speed at which the paper can be moved. The prototype machine, which was designed for a top speed of 3,000 wpm., has been operated, according to company officials, at speeds above 12,000 wpm. in the laboratory.
- **Reliability.** The direct translation of electronic impulses into a final form-print-out of electrostatic charges eliminates several intermediate steps, said to result in a high order of reliability, absence of errors and low maintenance cost.
- **Cost.** Machines to handle codes of differing complexity would vary in cost between $5,000 and $15,000 in production quantities, according to the company. Paper used by the machines costs about 0.8 cents per square foot, which is slightly more than high grade bond paper.

Other applications of the technique envisaged by the company are for labeling, strip printing, digital computer readout systems, page-printers and plotters, telemetry, high speed strip charting and facsimile.

# Transmission Unit Improves Accuracy

**Timonium, Md.**—Technique which reportedly improves accuracy of data transmission of conventional FM/FM telemetry by factor of 16 has been developed here by Hoover Electronics Co.

Increased accuracy is obtained at expense of using two sub-carrier oscillators and small device, called Vernitel, used in the aircraft or missile.

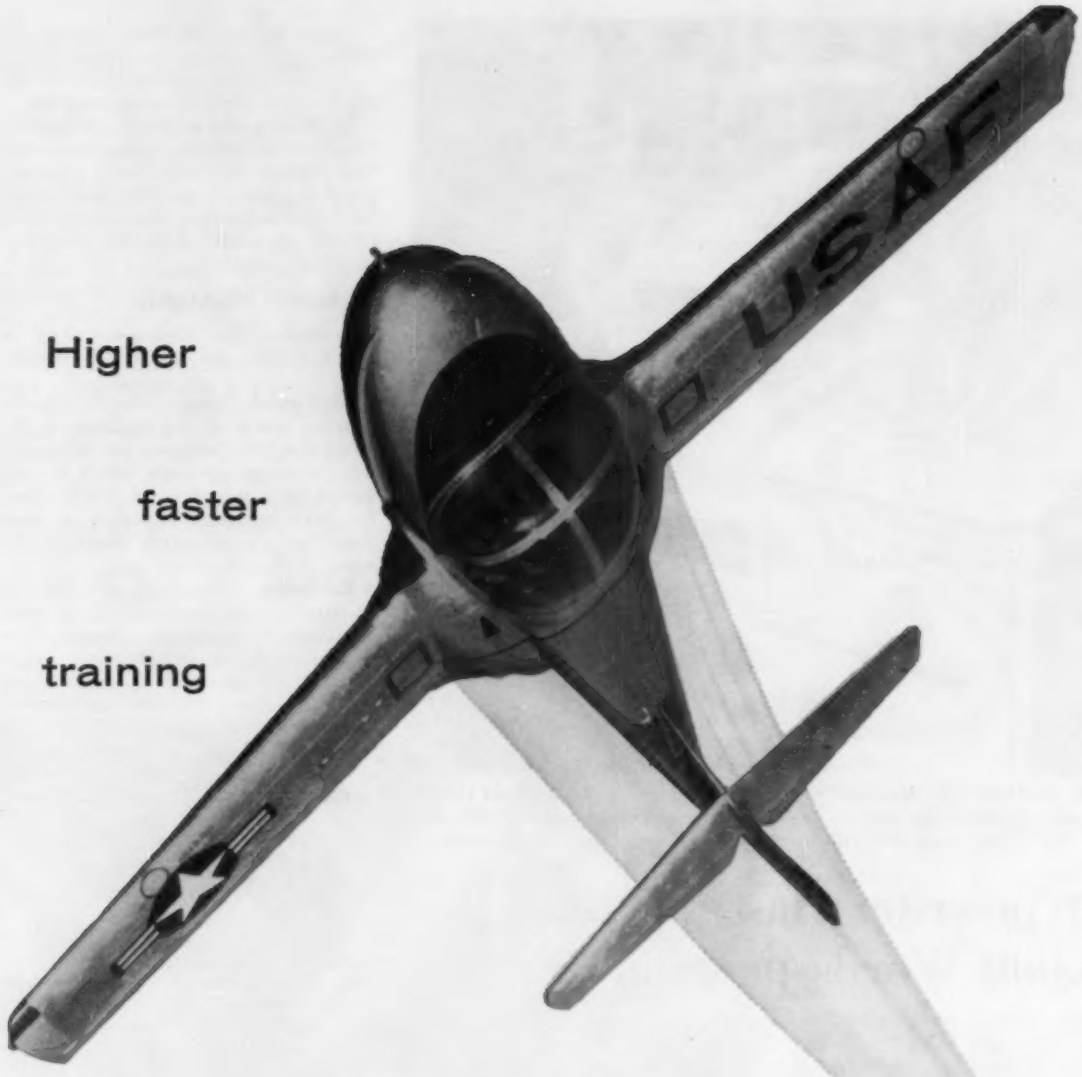
Vernitel first separates transducer signal into two voltages, one a "coarse" voltage at one of 16 discrete levels (in 0.32 increments), the other a "vernier" which is equal to the difference between the signal voltage and the next smaller one of the 16 discrete voltage levels.

The quantitized coarse voltage is applied to one sub-carrier oscillator, while the vernier voltage is amplified by a factor of 16, then applied to the

Higher

faster

training




in Cessna's

# T-37

Cadets in the U. S. Air Force now get a faster introduction to jet flying. Sitting side by side with their instructors, they're quickly learning to handle Cessna's T-37—a new, high-flying trainer with the characteristics of a combat jet. As a result, cadets are trained faster and easier (at substantial savings) to assure America's future in the air. Cessna Aircraft Company, Wichita, Kansas.

Cessna

**UNIT** separates signals into two voltages.

second sub-carrier oscillator. Composite signal is obtained on the ground by dividing the vernier channel voltage by factor of 16, adding this to the appropriate one of the 16 discrete voltages received on the coarse channel.

For example, if transducer output voltage is 3.3 v., the next smallest discrete voltage level would be 3.2 v. (10 x 0.32), which would be transmitted over one FM/FM channel. This would leave a residual voltage of 0.1 v. which when amplified by factor of 16, equals 1.6 v., the signal level that is transmitted over the vernier channel.

For an FM/FM system whose maximum error normally is 3%, the new technique reduces the error to about 0.2%, company says.

Present airborne Vernitel unit, completely transistorized, is designed for operating over temperature range of −54C to 85C, up to altitudes of 70,000 ft., and to withstand 0.06 in. double amplitude vibration over frequency range of 0 to 55 cps., 10Gs from 50 to 500 cps. and 5Gs from 500 to 2,000 cps., company says. Additional details may be obtained from the company at 110 West Timonium Road, Timonium, Md.

## Expansions, Changes In Avionics Industry

International Telephone and Telegraph Corp. has formed new unit, International Electric Corp., to manage production of Strategic Air Command Control System (465L) under recently awarded Air Force contract (AW Sept. 29, p. 23). Francis H. Lanahan, former head of ITT's service organization, Federal Electric Corp., has been named president of new company. Fred M. Farwell is named executive vice president.

Other expansions, changes recently announced by avionics manufacturers include:

• **Airborne Instruments Laboratory,** Mineola, N. Y. has formed new group known as Project STAR—Space Technology and Advanced Research—headed by W. E. Fromm. Approximately 225 persons, including 100 engineers and scientists, are "already at work on contracts which call for highly advanced electronic systems for nation's space programs," the company says. (Company reportedly is developing electronic countermeasures reconnaissance receivers for USAF's Sentry satellite.)

• **Infrared Industries, Inc.,** is building new facilities in Waltham, Mass., Research and Development Park, along Route 128. Company expects to occupy the 15,000 sq. ft. plant during January.

• **Radio Corp. of America** has moved newly formed Missile Electronics and Controls Department into new 135,000 sq. ft. facility at Burlington, Mass. New department, which includes RCA's former Boston Airborne Systems Laboratory, is headed by W. B. Kirkpatrick, former manager of Airborne Systems Dept. in Camden, N. J. Dr. R. C. Seamans, Jr. is chief engineer of new department.

• **Sylvania Electric Products, Inc.,** will build a 76,000 sq. ft. addition to its Electronic Defense Laboratory at Mountain View, Calif. Facility, which now employs 1,400 persons in programs for Army in field of countermeasures and electronic intelligence, expects figure to grow to 1,900 when new addition is completed.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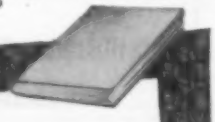

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Utilizing low-cost, light-weight M-D 3-Lobe Rotary Positive Blowers specifically designed for ground support equipment, Hussman Aircraft Div., St. Louis, build mobile air conditioners for Convair's new B-58 Delta-wing bomber. Hussman's MA3 unit furnishes 100#/min. of 45° air at 3½ psig thru an 8" flexible duct for cooling the complex instrumentation and guidance systems on the B-58.

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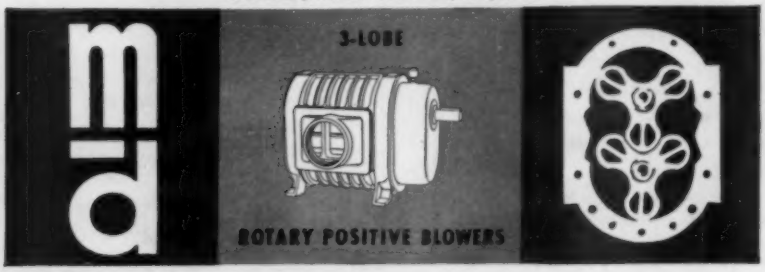



## FILTER CENTER

▶ **AMB Status Report**—During first 15 months of Airways Modernization Board's existence, agency has pinpointed 381 projects and tasks which will require developmental effort, currently has 45 of these under contract.

▶ **Long-lived Satellite Transmitter**—Minitrack radio transmitter in Vanguard I, powered by Hoffman silicon solar cells, is still operating after seven months in orbit.

▶ **Report On Infrared Detectors**—Report on the state of the art of lead sulphide detectors and photoconductors, including detailed performance and application data, has been prepared by Infrared Industries, Inc. For copy, write to company, P. O. Box 42, Waltham, Mass.

▶ **Count 'Em**—Avionics equipment used aboard Air Force's Convair F-106 interceptor contains more than 1,000 vacuum tubes and 4,000 semiconductor devices, Deputy Secretary of Defense Donald A. Quarles reported at recent National Electronics Conference in Chicago. Development of F-106's avionic equipment required more than 1,000 man-years of engineering and cost more than $100 million, Quarles said.

▶ **New Automatic Transistor Tester**—Machine for high-speed fully automatic testing of transistors, capable of running up to seven successive tests at rates up to 430 units per hour, has been developed by Stromberg-Carlson for Sperry Gyroscope Co. Machine can test for d.c. beta, a.c. beta, saturation and leakage. Company is completing similar machine for testing diodes, designed to check forward voltage, reverse leakage, Zener voltage and Zener impedance. Machine can be provided with temperature chamber which permits tests to be conducted at temperatures up to 200C. Only manual operation is the initial loading of the transistors. Machine sorts rejected transistors according to their defects.

▶ **Speedy Transistor-Magnetic Counter**—Simple transistor-magnetic binary counter, capable of operating at rates up to two million counts per second has been developed by Naval Ordnance Laboratory. Transistors are used as regenerative amplifiers to change magnetic state of cores when input pulse is applied. Each stage of the counter consists of a permalloy core with rectangular hysteresis loop, a transistor, a silicon diode and a resistor. Duration of output pulse is controlled by saturation flux

density of the core rather than by transistor parameters.

▶ **Ultrasonics to Check Solid Propellants**—Stanford Research Institute has developed technique for using ultrasonics to measure remaining serviceable life of solid propellants installed in missiles. Developed under Hughes Aircraft Co. sponsorship for use with Falcon air-to-air missile, technique applies electrical signal to transducer that is cemented to the charge, producing ultrasonic vibrations which are absorbed by propellant. Degree of ultrasonic energy absorption by propellant is indication of its remaining service life.

▶ **Signed on Dotted Line**—Major contracts recently announced by avionics manufacturers include the following:

• **American Machine & Foundry Co.,** $1.8 million contract from General Electric for radar antennas to be produced in AMF's Brooklyn, N. Y., plant.

• **Philco Corp.,** Philadelphia, a $2½ million contract from Army Signal Supply Agency for eight high-resolution airborne radars to be used in drone reconnaissance aircraft.

• **Ryan Aeronautical Corp.,** San Diego, $20 million contract from Navy for AN/APN-122 (V) airborne Doppler ground velocity indicator.

• **Servomechanisms, Inc.,** Hawthorne, Calif., reports $508,000 order from Radio Corp. of America for barometric altitude controllers.

• **Kin Tel Division of Cohu Electronics, Inc.,** San Diego, $300,000 contract from Douglas Aircraft for closed circuit television equipment to be used for remote observation of rocket engines under test at Camp Vandenberg, near Lompoc, Calif.

• **Mid-Century Instrumatic Corp.,** New York, $166,000 contract for missile tracking computers and plotters for use at Navy-managed Pacific Missile Test Range, Pt. Mugu, Calif.

• **Applied Science Corp. of Princeton** (ASCOP), $250,000 from Naval Air Training Center for mobile van containing both FM/FM and pulse width modulation (PWM) data reduction equipment.

• **General Electric Computer Department,** a $1.7 million contract renewal for operating computer center at Army Ballistic Missile Agency, Huntsville, Ala., through Sept. 15, 1959.

• **Laboratory for Electronics, Inc.,** Boston, $150,000 contract from General Electric's Aircraft Accessory Turbine Department for AD-10 electronic-magnetic controller to replace mechanical governor now used on drive for producing electric power.

• **Frank R. Cook Co.,** Denver, $140,000 contract for silver-zinc batteries to provide main electrical power for Atlas ballistic missiles.


*This announcement appears as a matter of record only.*

NEW ISSUE October 16, 1958

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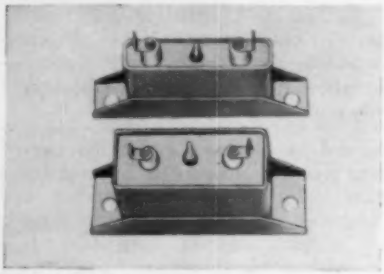
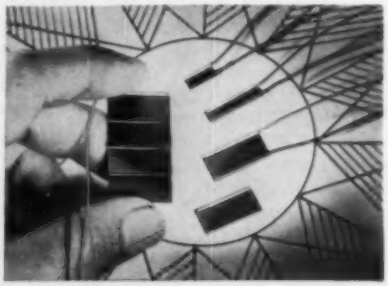
## NEW AVIONIC PRODUCTS

• **High temperature capacitor,** Type E-315, operates over the temperature range from −55C to 315C. Capacitance is 0.05 to 4.0 microfarads at 600 v. dc. with higher voltages available. Features are: no voltage derating, low capacitance and power factor variation,



hermetic sealing. According to the manufacturer, the E-315 has completed qualification testing of 1,000 hr. at maximum temperature and rated voltage. Bulletin No. SL-61 is available from Scintilla Division of Bendix Aviation Corp., Sidney, N. Y.

• **Silicon PNP transistors** for 1-4 mc. operation in severe avionic environments are available in four JETEC types: 2N1024, 25, 26 and 27. The alloy junction transistors incorporate a design feature that holds input resistance in all units to a uniform 35 ohm value. Higher collector voltages of the four units extend their use to gate circuits, amplifiers, regulators, and convertors where higher voltage and gain are needed. Sperry Semiconductor Division, Sperry Rand Corp., South Norwalk, Conn.



• **Silicon solar cells** with a conversion efficiency of 10% are said to be the most efficient of such cells currently available. Manufactured to military specifications, the units are capable of providing an output of about 9 watts/sq. ft. of active cell area in bright sunlight. Individual cells are obtainable, with or without color-coded pigtail leads, in sizes ¼ x 1 cm., ¼ x 2 cm., and 1 x 2 cm. Bulletin SR-275 is available from International Rectifier Corp., 1521 E. Grand Ave., El Segundo, California.

***British Accident Investigation Report:***

# BEA Viscount Crash Is 'Unexplained'

*(Following is a report of a court investigation into the crash of a British European Airways Corp. Viscount 802 submitted to H. A. Watkinson, Minister of Transport and Civil Aviation, by Roland Adams, Commissioner.)*

At 1516[1] hr. on Oct. 23, 1957, the Viscount 802 aircraft G-AOJA (hereinafter called "the aircraft") belonging to and operated by British European Airways Corp. (hereinafter referred to as "BEA") took off from London Airport to fly to Belfast in pursuance of a special charter for which purpose a special flight designation 542A had been allotted. The aircraft was manned by a crew of five and carried two passengers viz. a commercial employe of BEA and his wife. There was a small quantity of cargo on board of no significance in this inquiry. The laden weight of the aircraft was a very great deal less than the authorized maximum total takeoff or landing weight.

The earlier stages of the flight were normal and uneventful and at 1645 hr. the aircraft was taken over by the Precision Approach Controller for a GCA talk-down on runway 28 (276 deg.) in weather conditions which the Captain had good reason to think would allow him to come visual at or above his critical height of 500 ft. The talk-down itself was completely normal and not until the aircraft was half a mile from touchdown was the word "overshoot" mentioned.

Soon after "three quarters of a mile from touchdown" the aircraft was to the right of the center line and shortly afterwards was "well right of center line" and just after "half a mile from touchdown" the Precision Approach Controller said "if you're overshooting turn left five degrees on overshoot-over" to which the reply came ". . . overshooting."

At about this time a number of witnesses heard the aircraft "rev-up" to an engine note "just like a Viscount taking off" as more than one described it, and very shortly afterwards the occupants of the GCA van which was situated towards the western end of the runway and about 350 ft. to the south of its center line heard the aircraft pass over the van sounding like "a perfectly straightforward overshoot."

A second or two later the aircraft crashed still within the boundary of the airport in a position about 1,000 ft. to the southward of the western end of runway 28. All the occupants of the aircraft lost their lives.

The problem for the Court was to determine the cause of this change from the apparently normal to the catastrophic.

The aircraft was a Viscount 802 and was constructed by Vickers Armstrongs (Aircraft) Ltd., the aircraft serial number being 150. At the material time the aircraft was en route to Belfast in connection with a special charter to bring the Minister of Supply and members of his staff thence to London. This explains the unusually light loading already mentioned.

It is not proposed to set out here details of the engines and other components and equipment of the aircraft. The design, fitness, condition and standard of maintenance of none of these was in any way in question during the course of the inquiry. The documentation of the aircraft was complete and in order. No matters within this sphere are of any relevance to the problem facing the Court.

## THE CREW

Capt. Robert Malcolm Stewart, who was in command of the aircraft, was 35 years old, married, with one child. He joined the Royal Air Force in January, 1941, and flew chiefly transport aircraft. Having retired with the rank of Flight Lieutenant, Capt. Stewart joined BEA in September, 1946, and flew as a First Officer of Viking aircraft. He was promoted to Captain in 1950. In March, 1957, he completed a Viscount 802 conversion course and his last flight check was completed on Oct. 20, 1957. In all Capt. Stewart had flown a total of 7,496 hr. of which 316 hr. were on Viscount 802 aircraft.

He was in possession of a valid airline transport pilot's license No. 23780 entitling him to act as pilot of Viscount 802 aircraft on scheduled passenger services. In the last six months before the accident, Capt. Stewart had flown 301 hr. and had landed at Nutts Corner on 12 occasions.

There was abundant evidence before the Court upon which it could be satisfied that Capt. Stewart was a reliable officer who would be unlikely to take unjustified risks or disobey safety regulations. The evidence of all those who knew him indicated their appreciation of Capt. Stewart's high qualities as a pilot and as a commander.

First Officer William Gordon Tomkins was 35 years old, married, with two children. He joined the Royal Air Force in 1941 and during his service was awarded the Distinguished Flying Cross. He retired with the rank of Flight Lieutenant and in 1951 joined BEA. Serving at first as Second Officer in Viking aircraft he was promoted to First Officer in 1953. He completed a Viscount 802 conversion course in May, 1957.

This officer had flown a total of 4,739 hr. of which 259 hr. were on Viscount 802 aircraft. He was in possession of a valid senior commercial pilot's license No. 25423 and was entitled to operate as a pilot of Viscount 802 aircraft.

In the last six months First Officer Tomkins had flown 280 hr. All the evidence points to this officer having been competent and indeed above the average in carrying out the duties of First Officer.

Before Capt. Stewart left London Airport, he was briefed as to the weather conditions he was likely to experience during the flight and the usual documents were handed to him. At that time the most significant feature of the weather picture was a cold front which was approaching Belfast from the north. This led the forecasters to expect a deterioration in the weather as the front reached Belfast and an improvement after it passed; they expected it to clear through Belfast between 1600 and 1800 hr.

A fair summary of the briefing as to landing conditions to be expected at Belfast would be some cloud down to 300 ft. but improvement likely from 1600 hr.

The first material reference to the weather as affecting the aircraft came shortly after 1617 hr. when the Zone Coordinator and Supervisor at Nutts Corner commenced to talk to the aircraft. At that time, the Captain was considering diverting to Dublin from Portaferry but at 1618½ hr. he was told that despite a number of bad cloud reports that afternoon aircraft had been coming visual round about 500-600 ft.

The Supervisor then said "It always still seems to be very thin. I don't know if you've got enough fuel; it might be worth your while coming down to your critical height to see whether you could make an approach." The reply from the aircraft was "We'll do that, we've got a bit extra."

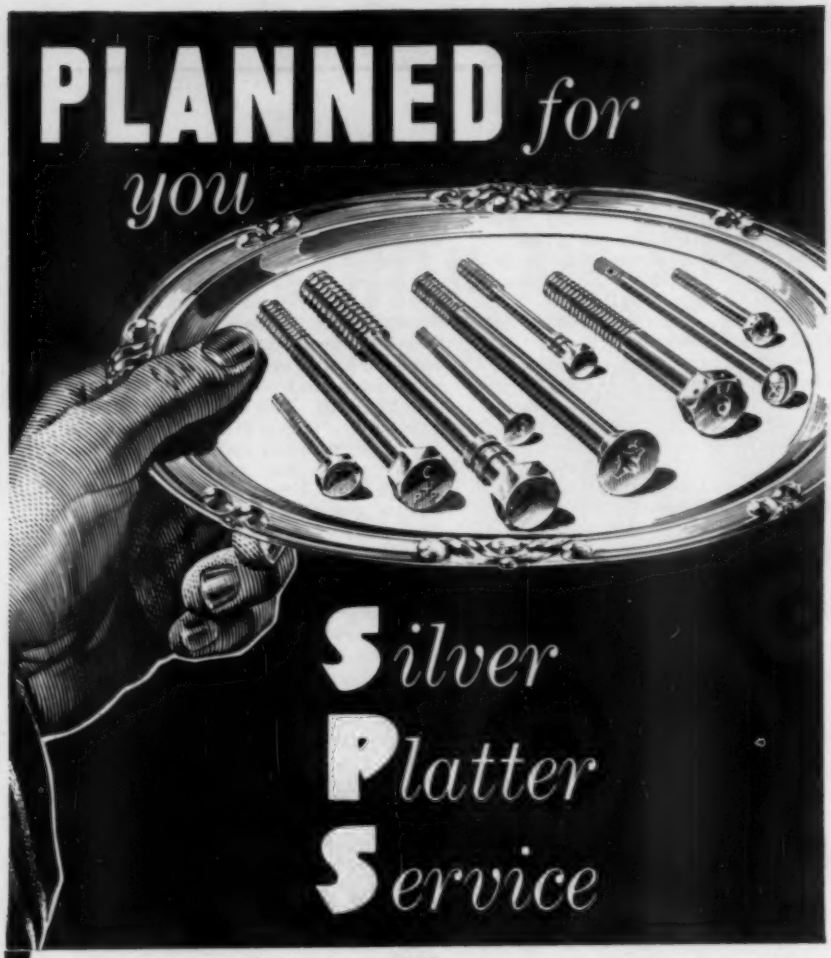
A perfectly normal intermittent conversation followed in the course of which the possibility of diverting to Aldergrove was discussed and shortly after 1638 hr., the aircraft said "if the Aldergrove weather has improved that much it presumably means the front is going through. I think we'd rather hang around for a little while and see if we can't get into Nutts Corner; we'll make an approach here anyway." In the same minute, the aircraft said "the cloud seems very thin, I can see the ground where I am at 4,000 ft."

At 1639 hr., the ground said "I think you've got a sporting chance on a 28 approach; it doesn't look too bad." The reference to "a sporting chance" meant "a sporting chance of becoming visual above your critical height."

After this exchange the aircraft continued on and at 1641 hr. when at 3,000 ft. was told that the approach would be a precision approach and at about 1645½ with the aircraft at 2,200 ft. and on a heading of 285 deg., the talk-down commenced. This was a normal and uninterrupted talk-down and it ended with the passage already set out above which came between 1649 **and 1650 hr.**

Four witnesses who were on the ground to the right of the approach path in an area between ¾ mi. and ½ mi. from the threshold were the only people at Nutts Corner who ever saw this aircraft. They all speak of fog on the surface and give

[1]Unless otherwise stated, all times in this report are GMT, all bearings and courses are magnetic and all heights are heights above mean sea level.

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varying estimates of the visibility. Only one of them was more than 500 ft. from the (produced) center line of the runway at its nearest point and he seems to have thought the aircraft was closer to where he was than was usual and lower.

Another witness thought the aircraft was higher than usual. Only one of these four witnesses mentions the landing wheels and says they were down. Almost immediately after seeing it, all these witnesses heard the aircraft "rev-up." No other witnesses saw the aircraft but several others including some experienced people heard the "revving up." To no one did it appear that the aircraft was in trouble or that what they were hearing was in any way unusual.

The crash occurred at 1651 hr. Nobody saw it. A number of people heard it. The best evidence is that the engines were running up to the moment of impact. A vivid flash followed by the noise of an explosion is the best summary of what was seen and heard by the witnesses.

## THE WRECKAGE

The consequence of the crash was a far-reaching disintegration of the structure of the aircraft. The careful and exhaustive researches of the Accidents Investigation Branch backed up by the technical staff of the operators, builders, engine builders and others have failed to point to any circumstance which affords elucidation of the problem before the Court.

This accident was a challenge to all these highly qualified and experienced people and they met the challenge with diligence and imagination. It is not their fault that the results are meager.

One finding based upon the condition of the wreckage which can safely be made is that at the moment of impact all three undercarriage units were fully retracted and locked. There was other evidence that on this type of aircraft it takes about 13 sec. from pressing the selector button for the undercarriage to reach the fully locked position. The Court has no reason to doubt that when the aircraft was approaching the eastern end of the runway the landing wheels were down and concludes that they must have been selected up at the moment the decision to overshoot was taken. It is impossible to conclude that undercarriage drag had any significant effect on airspeed at any material time.

### Flap Angle

The flaps were found in a condition in which it could be ascertained that they were near to the fully "up" position at the time of impact. The maximum flap angle on this aircraft was 47 deg. and the evidence would seem to indicate that the flaps had been traveling up to and had reached to within not more than 8 deg. from fully up.

Other reliable evidence suggests that Capt. Stewart would have selected 85% (40 deg.) flap upon identifying the approach lights which, for reasons which will appear, the Court considers he was able to do and almost certainly did.

It is reasonable to suppose that he initiated his upward flap selection immediately after raising his undercarriage.

There was an equivalent angle on the elevator trim of 4 deg. up, equivalent to one

## Fins Added to Yak-24

**Latest photos of the Soviet Yak-24 Horse helicopter show the addition of two vertical fins at the tips of the butterfly tail surfaces. Control surface mounted on the tail itself is not new. Added fin area probably was needed for better directional control at high speeds when increased drag on the forward rotor may produce a tendency for the rear rotor to overtake, throwing the helicopter into a skid. Photo was taken at a Russian air show.**

division nose-heavy in the cockpit. The aileron trim was slightly starboard wing low. Neither of these matters is considered significant.

A study of the ground at the place of impact suggests that the port wing had struck the ground a little before the starboard wing but not appreciably so. There were positive indications that the aircraft was not inverted.

Much careful work was done to determine if possible the angle of inclination at which the aircraft struck the ground and it is reasonable to make a finding that it was between 45 and 60 deg. from the horizontal.

It is also reasonable to conclude that the heading of the aircraft was 204 deg. or 72 deg. to the left of the line of runway 28.

The mean line of scatter of the more important parts of the debris was, however, about 240 deg. and this may indicate that immediately before the impact, the aircraft had been heading higher than 204 deg.

### Propeller Condition

The 16-propeller blades had all been torn from the hubs and the indications were that they were all rotating under similar conditions at the time of impact. They had been at a pitch setting within the normal constant speeding range.

The engines were very badly smashed up but enough could be observed upon examination to confirm that they had been rotating at the time of impact and there was no indication of any failure or fire in any one of them.

The more delicate instruments in the aircraft were so badly destroyed that beyond saying that the gyros of the twin compass system were rotating at the time of the impact, those who examined what was left were unable to point to any useful conclusions.

Having regard to a much publicized hypothesis relating to a screw driver which is discussed later in this Report it is convenient to record here that the parts of the control system in which a jam could occur were recovered and examination of them has produced no evidence of a jam. Although it is not, and was not claimed by any witness to be conclusive the best evidence based on examination of the wreckage is that none of the controls were jammed before the impact.

### COMMENT AND DISCUSSION

It has already been mentioned that Capt. Stewart was familiar with the approach to Nutts Corner and it has been emphasized that the talk-down on the fatal occasion was normal. Subject to recognition of the limitations of any generalized evidence it is worth recording that the experience of an officer who knew him well and had often flown with him as a copilot was that Capt. Stewart was accustomed to fly his aircraft manually after take off until he reached an altitude of 4,000-5,000 ft. When approaching his destination he used to disengage the autopilot from the time he entered the aerodrome control area and fly manually until he had landed the aircraft.

According to the same witness, Capt. Stewart's practice was to leave the clutches engaged with the auto-pilot selected out. This was the general practice at that time.

Capt. Stewart was familiar with and favored the monitored approach procedure which BEA recommends. Whether he or his First Officer did the flying or the visual looking out was a matter for his own decision in the circumstances of any individual let-down.

He was regarded as a meticulous watcher of his approach speed.

There was good evidence that First Officer Tomkins was familiar with the monitored approach procedure.

It is convenient here to record that al-

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though the evidence was conflicting the Court was satisfied that during the whole of the period of the talk-down 11 out of 13 of the red low intensity approach lights, the red obstruction lights, the green low intensity threshold lights and all save one of the white directional runway lights were alight.

### Instructions Followed

On the balance of probability the Court was satisfied that Capt. Stewart was at no time in breach of the provisions of the Air Navigation Order 1954 relating to Aerodrome Meterological Minima for aircraft registered in the United Kingdom and that he complied with the instructions issued from time to time by BEA which cover every aspect of approach and landing in limited visibility.

In all the circumstances the Court cannot favour any explanation of this disaster based upon pilot error.

If pilot error is to be eliminated from among the probable causes of this accident it becomes the more necessary to study those factors which might produce sudden catastrophe by reason of some malfunctioning of the mechanisms of the aircraft which the most careful and skillful pilot would be unable to correct. The possibility of something jamming the controls is one that has always been in the minds of those concerned with the design and operation of aircraft.

It was in evidence before the Court that BEA has a standing order which has been in existence for many years, the intention of which is to eliminate any possibility of loose objects being left about in the cockpits of aircraft. Provision is also made requiring those who are responsible for carrying out the various prescribed "checks" to satisfy themselves that no tools or similar objects are left behind when panels are closed or in any other section of an aircraft in which work was required in the course of the "check."

So far as the Viscount 802 is concerned, the best evidence was that the only one of the controls into which a foreign object could find its way was the aileron servo motor on the port pilot's platform. After going through the complete control system a reliable witness from the Service Branch of the builders of Viscount aircraft was unable to find any other place into which any but insignificant foreign objects might get.

It is the practice of these builders to issue from time to time to operators of their aircraft bulletins suggesting modifications which research and development have shown to be desirable in the case of any given type.

On Sept. 19, 1957, or rather more than a month before the accident now under consideration, the builders put out a bulletin recommending the covering of an aperture through which, as their Inspection Department engineers could see, objects might fall into the control mechanism governing the ailerons. This recommendation was not made because of any actual experience of something of the sort happening but because the engineers appreciated that such a thing could happen.

Recommendations for modifications put out by these builders are given a priority notation ranging from "essential" down through "highly desirable" and "desirable" to "optional" and the modification now under discussion was given the value "desirable."

### Jamming Incident

This modification was not immediately put in hand by BEA: a large number of "desirable" modifications are suggested from time to time and these are studied and applied as and when convenient. On Nov. 4, 1957, a little under a fortnight after the accident under investigation, there was an incident involving the jamming of the aileron controls of another Viscount 802 aircraft by a lens fitted into a cylindrical metal case which had fallen through this same aperture. A few days later a similar object fell through the same aperture on another aircraft and worked its way aft on the lower floor and lodged in a vulnerable

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spot again impeding the movement of the controls.

It was conceded by a Senior Development Engineer of BEA that, up to the time when the modification of covering the aperture in Viscount 802 aircraft was put into effect a little later in the month of November, what had happened with these objects might have happened in any Viscount 802.

Other evidence supports the view that, if the controls became jammed by some small foreign object, even though the pilot could by manual force overcome the resistance so as to be able in a matter of seconds to operate the controls to their fullest extent, the moment of delay would be sufficient to produce a factor of indecision in the mind of whoever came up against it.

### Screwdriver Found

There is not in this case a shred of evidence which would justify a finding that any interference with the controls had anything to do with the fatality. Two circumstances only have made it necessary for the topic to be discussed. The first of these is the elimination of any probability of pilot error. The second is the wide canvassing of the possible significance of the finding among the wreckage of the aircraft of a small screwdriver of the type commonly used by electricians in a badly distorted condition which indicated that it had been subjected to severe stresses.

Upon the totality of the evidence given in this investigation it would be wholly wrong to allow suspicion about this screwdriver to rear its head.

In the first place no one will ever know whereabouts in the aircraft it was. It was found among the general debris unrelated to any other object. There was reliable evidence to the effect that the distortion which it had suffered might well have been caused by any one of a multitude of conditions which could have been met with in a crash at the sort of speed which must be envisaged in this case.

Many experiments were carried out with precisely similar screwdrivers placed in different attitudes in the aileron controls of a Viscount 802. A careful study was made of the screwdriver itself and of the parts of the wreckage upon which it might have impinged had it found its way into the aileron controls of the aircraft.

The Court gave careful attention to the impressive body of scientific evidence which was given upon this topic by witnesses of repute each one of whom was open to cross-examination. It is not considered necessary to examine that evidence in detail here. Such examination could lead to no positive finding.

While it was clearly possible for a foreign object like this screwdriver to have fallen through the aperture into the aileron controls the Court feels bound to accept the evidence of the scientific investigators that it is not probable that this screwdriver was jammed in the aileron controls on the occasion of this crash.

Since the date of this accident, cases have been reported of inadvertent engagement, or failure to disengage of the servo-motor clutches of autopilots of the type fitted in the aircraft when the power switch was in the off position. The manufacturers of the autopilot carried out a detailed examination

# CABLE and WIRE LEADS

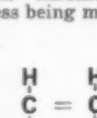
By HOWARD E. PENDERGAST

*Technical Director, Rex Corporation*

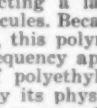
## Comparative Properties of Insulating Plastics

Technological advances by manufacturers of electrical and electronic components and equipment are challenging the plastics industry to keep pace. The need for new polymers and copolymers that meet more critical performance requirements is constantly growing. Demands include increased operating temperature range, greater reliability, improved aging and stability, better chemical and radiation resistance and many others. An evaluation of currently available plastic insulating media reveals the progress being made to meet demands.

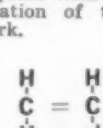
**Polyethylene** is the logical starting point for a comparative study of plastic insulating. It is one of the most commonly used. Here, the basic carbon-hydrogen molecule is in virtually perfect balance. Polymerization is accomplished by breaking the double bond and connecting a large number of identical molecules. Because of its electrical balance, this polymer is excellent for high-frequency applications. Greater use of polyethylene however, is restricted by its physical properties: relatively low operating temperature and abrasion resistance. These shortcomings have been overcome to some extent by the introduction of "linear" polyethylene with its more controlled orientation of the three-dimensional network.



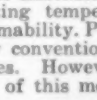
**Polyvinylchloride (PVC)** is a modification of the polyethylene structure with one chlorine atom replacing one hydrogen atom. This results in physical properties that surpass those of polyethylene: greater abrasion resistance, better dimensional stability, higher operating temperatures and decreased flammability. PVC is readily extrudable by conventional thermoplastic techniques. However, the electrical unbalance of this molecule precludes the use of PVC at elevated frequencies.



**Monochlorotrifluoroethylene,** more commonly known as Kel-F*, is a modification of PVC with fluorine replacing hydrogen. This substitution, though difficult to achieve, pays off in still-further improved physical properties. Fluorocarbons are more difficult to process than PVC and other carbon-hydrogen linkages. But both the resin manufacturers and the insulation fabricators have made great technological advances in the past two years. The result is an insulating medium offering excellent physical, thermal and chemical properties.



**Tetrafluoroethylene,** best known as Teflon**, is produced by the total substitution of fluorine for hydrogen in the polyethylene molecule. Like the carbon-hydrogen molecule in polyethylene, this fluorine-hydrogen molecule is in excellent electrical balance and, therefore, is well suited for high frequency applications.



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| High Temp. | 100°C | 60°C to 105°C | 150°C | 200°C | 105°C (Heat Stabilized Grade.) |
| Dielectric Const. | 60 cycles 2.3<br>103<br>106<br>109 2.3 | Depends on Compound | <br><br>2.27<br>2.38 | 2.0<br>2.0<br>2.0<br>2.0 | 5.3<br>—<br>3.5<br>— |
| Power Factor | 60 cycles<br>103<br>106 | Depends on Compound | <br><br>.0082 | .003<br>.003<br>.003 | .06<br>.05<br>.03 |
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of the auto-pilot equipment salvaged from the aircraft from which it appeared that there was nothing wrong with the autopilot and that it was not energized nor were the clutches engaged at the time of impact.

The conclusions reached above make it necessary to refer to another possible cause of the castatrophic end of what began as a normal over-shoot.

Careful work was done in the course of a study by an expert to try to establish the flight path followed during the final dive and particular attention was paid to the possibility of a bunt maneuver or of a partial recovery from a stall.

The general conclusion reached by the careful worker in this field went no further than to record that it appears possible to obtain conditions at impact similar to those reported without requiring any structural failure or unserviceability of the aircraft but also that the maneuver required would be of a fairly violent nature.

It is therefore necessary to face the possibility that something may have deceived the pilot into some violent maneuver of the kind envisaged. It would seem that the only possible source of such deception would be the flight system and associated instruments.

All that was recovered from the wreckage was subjected to an exhaustive examination by an impressive body of experts and they failed to find anything which pointed to the malfunctioning of any instrument or indicator which could have led the pilot into a disastrous operation of the controls.

## CONCLUSIONS AND FINDINGS

The Court having carefully considered the possibilities in this unhappy case concludes that none of them are probabilities and accepts the submission specifically made on behalf of the Attorney-General that this must remain a wholly unexplained calamity.

It is desirable that consideration should be given to the disciplinary aspect of the switching on and off of aerodrome lighting. In this case there was a conflict of evidence (not material, as it turned out,) between local residents and the airport staff as to whether the approach lights were on when the aircraft was coming in to land. The Court resolved this conflict in favor of the evidence given by the officials but not without some misgiving. It must help the man who is responsible for seeing that lights are switched on or off as is appropriate to the weather conditions prevailing if he knows that as a matter of drill he must make some record of the times at which he performs these duties. It is not for the Court to suggest the method by which or the form in which such records should be made but it is reasonably assured that some such drill could be insisted upon without putting any appreciable burden upon the personnel concerned.

The introduction of the bent screwdriver into this inquiry brought into prominence another matter within the sphere of discipline. This object was handed to the Investigating Officer of the Accidents Investigation Branch who was in charge of this case by an emplove of the operators on the second or third day after the wreckage had been taken into a hangar for examination. The Investigating Officer put it aside in a box along with some other small components which were awaiting more detailed

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examination and when several days later he went to find it, it had gone. He at once caused inquiries to be made and found that the screwdriver had been picked up by a person employed at the airport, straightened by him and presumably used again as a screwdriver, no doubt in all innocence and good faith.

Upon being asked in whose custody the objects put aside were, the Investigating Officer answered "They are indirectly in my custody." When pressed to say in whose custody the objects were directly he said, "This particular screwdriver was in the custody of the police of the airport, I imagine." He went on, "I asked to have the hangar in which I had this wreckage impounded guarded by the police."

In this case, the screwdriver was not taken and tampered with by an ordinary member of the public to whom the police could deny access to the hangar but, as has been said, by one of the persons detailed to assist in the moving of the wreckage and as such authorized to be in the hangar and so to have access to the impounded objects.

Again it is not for the Court to devise security methods designed to prevent this sort of thing happening again but it expresses the strong view that somebody ought to.

Every case in which the possibility of some outside object fouling the controls of an aircraft has to be canvassed emphasizes the existence of such a possibility. A great deal of the time of this inquiry was occupied in considering the possible implications of the finding of an unaccounted-for screwdriver among the wreckage.

It is clear that the possibility of loose objects finding their way into the control mechanisms of aircraft and jamming them is in the mind of all concerned with the design, operation and flying of aircraft.

The Court takes this opportunity of calling for constant vigilance in this respect and for the devising of drills and disciplinary


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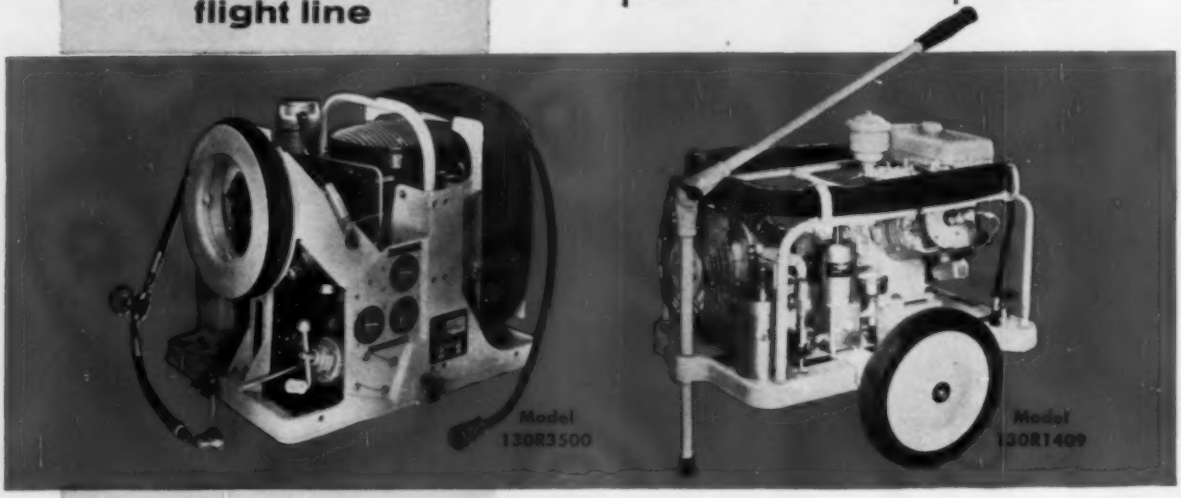

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sanctions directed to the elimination so far as may be possible of carelessness which may lead to the leaving of tools or other objects loose in an aircraft in such a way as to create any possibility of the sort of mischief which has had to be considered in the course of this investigation.

### QUESTIONS AND ANSWERS

The Court's answers to the question submitted by the Attorney-General are as follows:—

**Q. Who were the owners** and operators of the aircraft?

A. British European Airways Corp.

**Q. At the time of the accident:**

(a) **Had the aircraft** been properly maintained in accordance with the current accrued maintenance schedules?

(b) **Was the aircraft** properly loaded and trimmed?

(c) **Were the crew properly** licensed and adequately experienced for the flight?

A. (a) Yes.
(b) Yes.
(c) Yes.

**Q. What was the cause of the accident?**

A. Unknown.

**Q. Was the accident due to,** or contributed to, by the wrongful act or default of any party or of any person in the employment of that party?

A. Subject in logic to the answer to question 3—No.

ROLAND ADAMS
B. J. L. GREENLAND
S. B. BEEVERS.

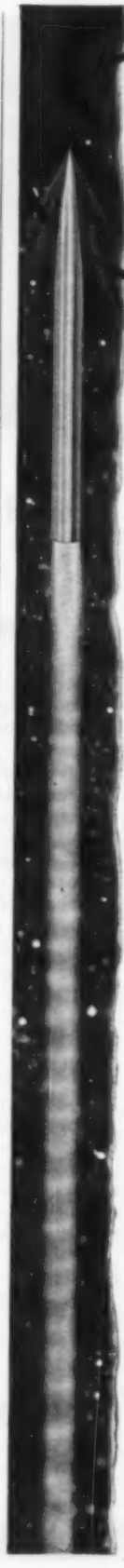
## Oils More Effective When Air Is Absent

**San Antonio**—Southwest Research Institute has found that certain lubricants have an increased capacity for lubricating high-speed gears when they operate in an airless atmosphere. Lubrication studies are being conducted here under Air Force contract.

Southwest Research Institute discovered that gears lubricated by straight mineral oil and operated in airless atmosphere show a marked increase in load carrying capacity. Nitrogen or argon replaces air in the operating environment. The same results were obtained when mineral oil was fortified with phosphorous, sulphur and chlorine type additives.

Data gathered so far indicates that load-carrying capacity is approximately doubled in an environment where air is removed or where the lubrication area is saturated with an inert gas like nitrogen. Studies are now under way on the effect of this phenomenon on other lubricants.

Southwest Research Institute points out that increased load-carrying capacity can be an important factor in keeping gear weight to a minimum in any system. Advantages are anticipated in design of missile systems because of the problem of providing adequate lubrication to missile powerplants.

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**PHYSICIST**—Familiar with the physics of gases and liquids, mechanical and electromagnetic wave propagation within these media.

**SOLID STATE PHYSICIST**—To work on electronic elements.

**MAGNETO HYDRODYNAMICIST**—To work on advanced propulsion systems.

**APPLIED MATHEMATICIAN**—Experience in logical programming of systems and interest in communication and probability theory.

Your complete resume should contain personal, educational, experience data, and salary requirements. Send to DIRECTOR OF PLACEMENT. All replies will be held in strict confidence.

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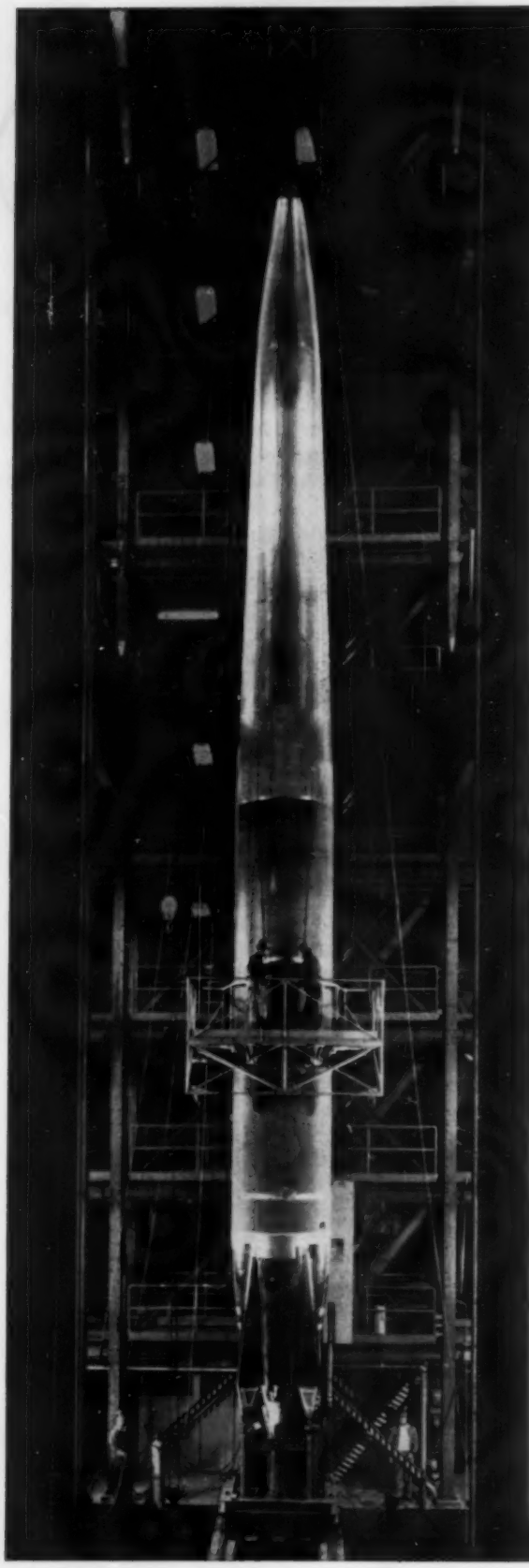

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This is just one of the many specialized facilities and tools that we have built up in the last ten years. During this decade—because of our complete responsibility for the development of a major weapon system—we have also piled up a wealth of experience in many related fields.

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**MISSILE DEVELOPMENT DIVISION**

North American Aviation, Inc.

## WHO'S WHERE

(Continued from page 23)

### Changes

Rocketdyne, a division of North American Aviation, Inc., Canoga Park, Calif., has announced the following appointments: **V. L. Just**, assistant program engineer for the Jupiter engine program and the H-1 program for the Army Ballistic Missile Agency; **D. J. Sanchini**, assistant program manager for the Air Force sponsored E-1 and F-1 programs for high-thrust liquid propellant rocket engines.

**Melville W. Robinson, Jr.**, chief engineer, Callery Chemical Co., Pittsburgh, Pa.

**Adm. Stuart S. Murray** (USN, ret.), assistant to the general manager, Aerophysics Development Division, Curtiss-Wright Corp., Santa Barbara, Calif.

**Boeing Airplane Co.**, Seattle, Wash., has announced the following appointments: **Portus D. Boyce**, market manager, and **Howard C. Tinney**, chief-business planning staff, Systems Management Office; **Carl A. Krafft**, assistant manager of the IM-99 (Bomarc) Weapon System, Pilotless Aircraft Division; **George Nible**, superintendent-sub assembly, Seattle Division.

**Robert R. Burns**, assistant director of domestic commercial sales, Douglas Aircraft Co., Inc., Santa Monica, Calif.

**Roger L. Sisson**, manager-systems department, Tactical Operations Central Project, Computer Division, Aeronautics Systems, Inc., subsidiary of Ford Motor Co., Santa Ana, Calif.

**Robert H. Lane**, director of public relations, Goodyear Tire and Rubber Co., Akron, Ohio.

**Robert H. Bloomberg**, director of plans and contracts, Air Logistics Corp., Pasadena, Calif.

**Robert C. Schofield**, senior application engineer-powerplant products, Marquardt Aircraft Co., Van Nuys, Calif.

**Charles J. Gilbert**, administrative engineer, the Sierracin Corp., Burbank, Calif. Also: **Donald J. Farnworth**, research engineer, and **Howard W. Tryk**, field service engineer.

**David Dows, Jr.**, director of public relations and advertising, Airwork Corp., Millville, N. J.

**William G. Coe**, Pacific Division manager, Los Angeles, Calif., Mycalex Corp. of America, Clifton, N. J.

**James Ryan**, sales engineer in charge of the newly established Washington, D. C., office, C. P. Clare & Co., Chicago, Ill.

**Col. William M. Frash** (USMC, ret.), customer relations manager, Aerojet-General Corp.'s Solid Rocket plant, Sacramento, Calif.

**C. W. Finnigan**, director-commercial engineering, and **C. Wright Reiniger**, sales manager-missiles, Crosley Division, Avco Manufacturing Corp., Cincinnati, Ohio.

**Warren F. Filer**, assistant manager-flight operations, Beech Aircraft Corp., Wichita, Kan.

**Stanley Schneider**, manager of engineering, Helipot Division, Beckman Instruments, Inc., Newport Beach, Calif.

**James M. Canaris**, director of engineering, The Briggs Filtration Co., Washington, D. C.


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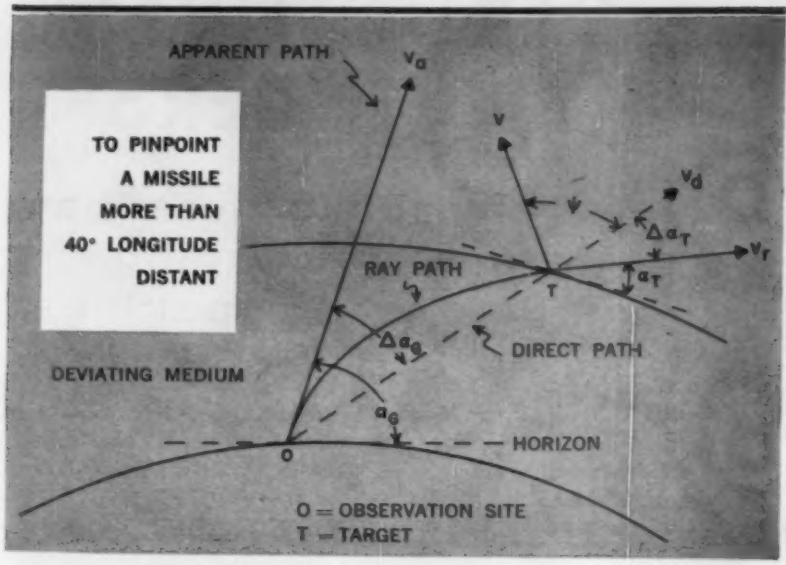


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**Research Engineer. Engineers with experience** in the general planning and development of air defense missiles, ballistic missiles or space research programs. Wanted for work in the Washington, D. C. area in a government agency at about the $10,000 to $11,000 per annum level. Please send your resume to P.O. Box 7118, Apex Station, Washington, D. C.

**Missile Engineer. Engineer with experience in** the general planning and execution of guided missile flight test programs including requirements for facilities, communication, instrumentation, data reduction, number and frequency of tests. Wanted for work in the Washington, D. C. area in a government agency at about the $11,000 per annum level. Please send your resume to P.O. Box 7118, Apex Station, Washington, D. C.

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(Continued on page 120)

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The vigorous engineering climate at Convair-San Diego is the result of large, important and long-range programs:

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Ann Arbor, Michigan

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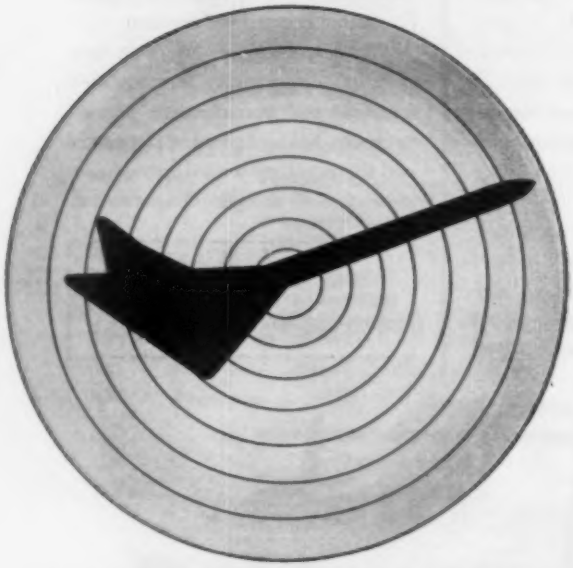
# WHAT IT'S LIKE TO BE A CREATIVE ENGINEER AT IBM



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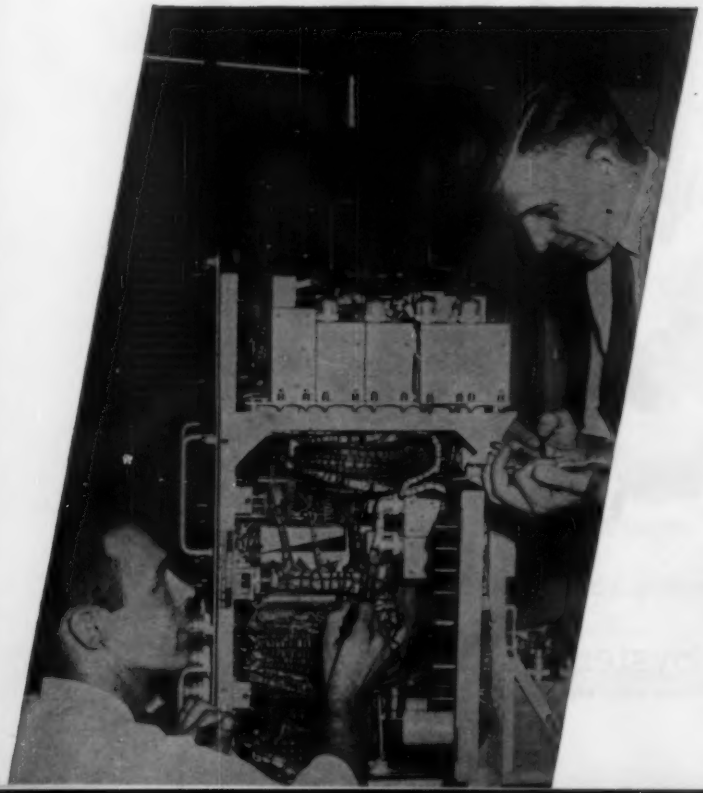

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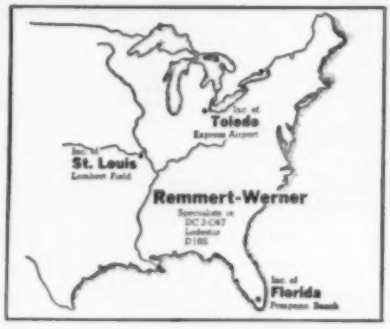


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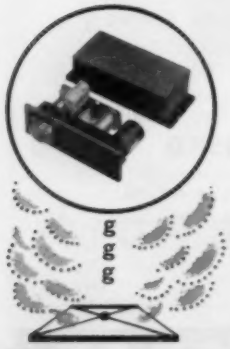

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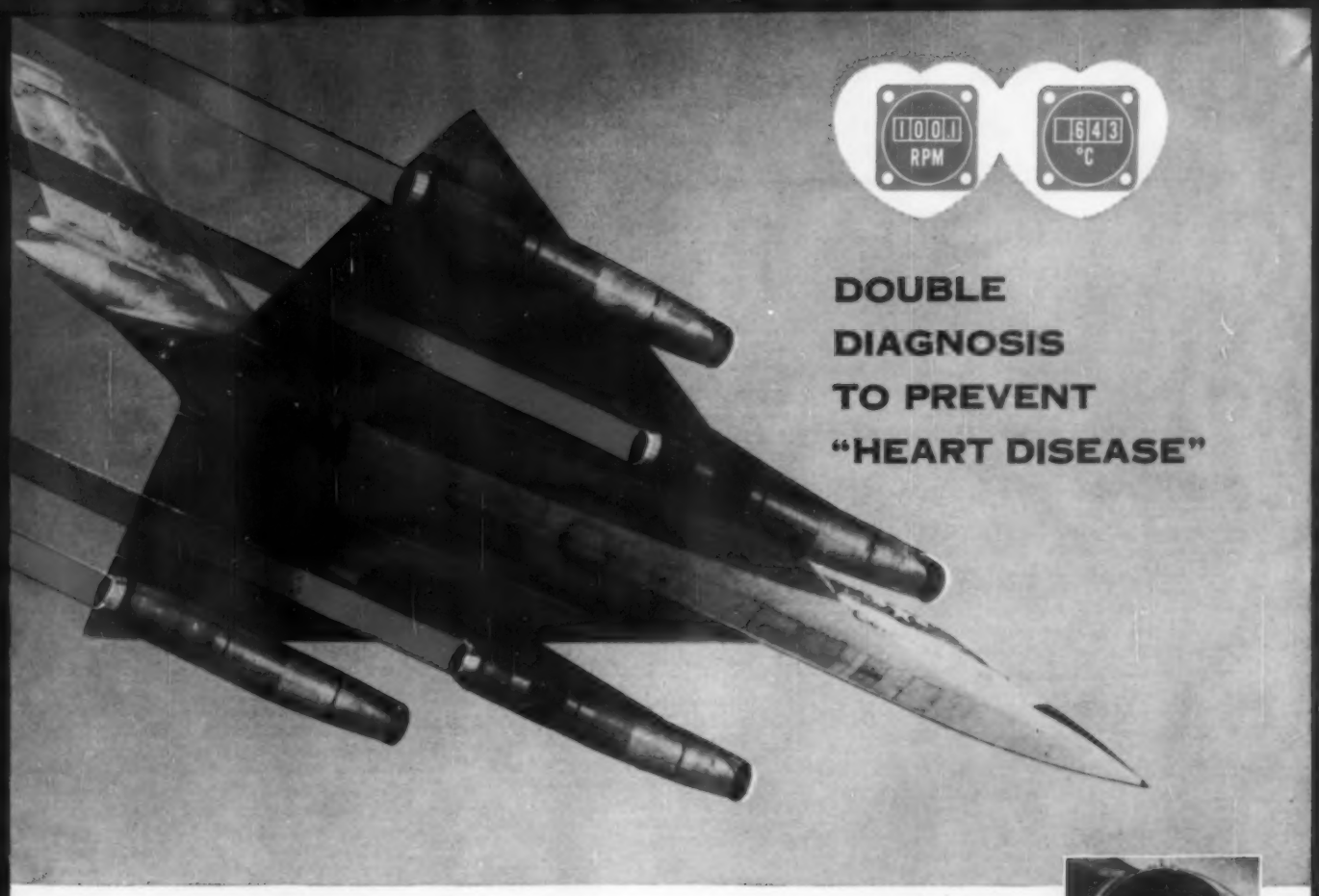


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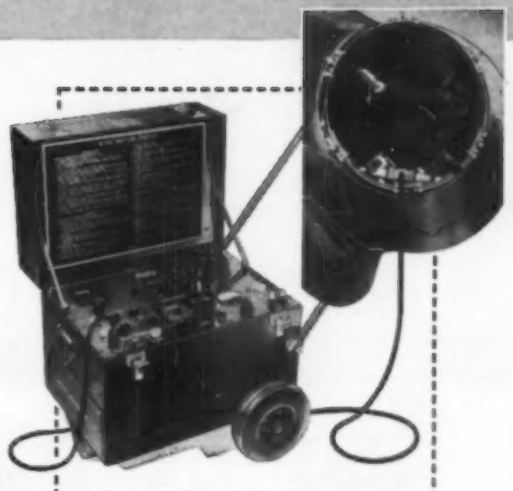

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# LETTERS

## Too Much on 707?

Being a faithful reader of your magazine, which I feel is the best of its kind on the market, I feel gives me the right to make the following complaint.

I can't help thinking that much publicity is given to the Boeing 707 and very little to competitive jet aircraft. Your articles on the 707 are very interesting and should continue, but I feel that more information on the progress of the DC-8 and others should have equal publicity. I mention DC-8 because I happen to work for the company building such. Let it be known that the feelings expressed in this letter are mine and do not necessarily conform with those of the company I work for.

Robert Barron
Lakewood, Calif.

(*Limited space prevents listing all items, articles and pictures Aviation Week has published on such airplanes as the Convair 880, Convair 600, Douglas DC-8 and Lockheed Electra, but the following references are representative of our major coverage. Convair 880:* (1957) *June 17, p. 82;* (1958) *Feb. 3, p. 40, p. 45; March 17, p. 64; Oct. 13, p. 41. Convair 600;* (1956) *April 9, p. 99;* (1958) *Aug. 4, p. 38; Sept. 8, p. 50; Sept. 15, p. 92. DC-8:* (1958) *April 21, p. 102; April 28, p. 60; June 9, p. 29. Lockheed Electra:* (1958) *March 31, p. 46; April 7, p. 79; Oct. 20, p. 62—Ed.*)

## Why Technology Lags

Many a matured aeronautical engineer concurs with your editorials which are constantly reminding readers of our loss of technological margins with the Russians, our false complacencies, late delivery of needed weapon systems, etc.

However, many of us believe you have overlooked two additional reasons in your editorials which play a weighty share to this technological lag. Namely, the inefficiencies and attitudes of our prime weapon system contractors, and the lack of our government procurement agencies to force our prime contractors to provide the desired weapon system they need and on time. For example, a major missile program is now one and a half years behind its firing schedule; some of our first line weapon systems are or will be relatively ineffective in combat due to the fact that they are failing so fast they cannot be kept available for combat, and some of our weapon systems are several years behind schedule for combat use.

The question is, why does this condition exist? Of course, there are many accumulative reasons, but a prime reason is believed to be the lack of technological and organizational maturity with many of our engineering management personnel working for our prime weapon system contractors.

You cannot expect efficiency, matured attitudes, and well balanced engineering decisions and policies unless they are rendered by matured engineering personnel. When poor decisions are made by these men, you have inefficient weapon systems, unreliable weapon systems, slippage in schedules, false philosophies, tremendous increase in costs, and false excuses to cover up blunders. This does not include the poor directions these same men pass on to their subordinates and colleagues.

Most of our prime contractors' engineering management personnel today are chosen from men with highly specialized engineering fields—such as doctor of physics, structures, group engineer, etc. This type of man is not technically balanced to make weapon system decisions or manage engineering projects because he has not had the personal firsthand background experience to make him technically matured. Engineering management personnel today require the combination of personal experience in electronics, flight test, customer operation, maintenance, procurement, manufacturing, project engineering, design, analytical design, and engineering before he is qualified for engineering management. The only way to gain this necessary experience is for the prime contractors to establish long range training programs (about 10 years) with incentives to produce such men. Our engineering managers more or less grow like Topsy, and this is rather borne out by our loss of technological margin with the Russians, our slippage in schedules, high development costs, and inadequacy of some of our first line weapon systems.

20 Year Aeronautical Engineer
San Diego, Calif.

***Aviation Week welcomes the opinions of its readers on the issues raised in the magazine's editorial columns. Address letters to the Editor, Aviation Week, 330 W. 42nd St., New York 36, N. Y. Try to keep letters under 500 words and give a genuine identification. We will not print anonymous letters, but names of writers will be withheld on request.***

## Limited Certification

Although not nearly important as other pressing issues, it does seem time to look into overhauling some of the moth-eaten CAA regulations.

With the placing on sale by the government of a number of excellent surplus aircraft, such as North American T-28s, Grumman F8Fs, Lockheed P2Vs and Consolidated PBY-6As, buyers find themselves unable to fly these airplanes for their own personal uses solely because the old limited certification arrangement was declared finished on Jan. 1, 1950.

However, the pigeon-brained powers that be in CAA say blessings on thee, little man, to anybody that builds a Mickey Mouse experimental lightplane at home in the garage and gives a rousing "well done" if you decide to do a little night instrument, passenger carrying-for-hire in your 1929 Curtiss Robin (CAA approved, Standard Category), which, after all, is safe as can be with that trusty 1918 vintage OX-5 engine (Oh yessir, it's wearing a CAA type certificate number on its chest).

E. D. Weiner
Los Angeles 46, Calif.

## Scrutinizing Salaries

In general one can find very little to disagree with in your editorials, especially the one entitled "Space Team Leaders" of Aug 18. Your quality of calling a spade a spade is a much needed one both in industry and in the government. It is a very unfortunate situation for this country (in many aspects) that the best qualified scientific and technical personnel of high integrity, such as Dr. Dryden, are not appointed to top government positions especially when they are available for such positions. Maybe this is due to a lack of genuine scientific and technical ability and/or honesty as well as to political reasons at high levels in the government. Also, it seems that the badly needed sense of urgency for real scientific research (programmed on a sensible basis) somewhat more prevalent throughout the government last November has subsided in favor of the usual complacency or pseudo-scientific stunts possibly to be rekindled again only by further dramatic demonstrations of real significance in the sky or elsewhere by some foreign power.

Along somewhat similar lines one is inclined to conclude that salaries for scientific and engineering personnel working on government contracts come under close scrutiny and justifiably so, however, it might also be asked if other expenses (such as managements' salaries) are scrutinized as closely. If managements' salaries are hidden in overhead costs while those of technical personnel are represented as an itemized expense (possibly exaggerated on paper so that overhead costs on paper appear lower) it is quite probable that they are not examined very closely.

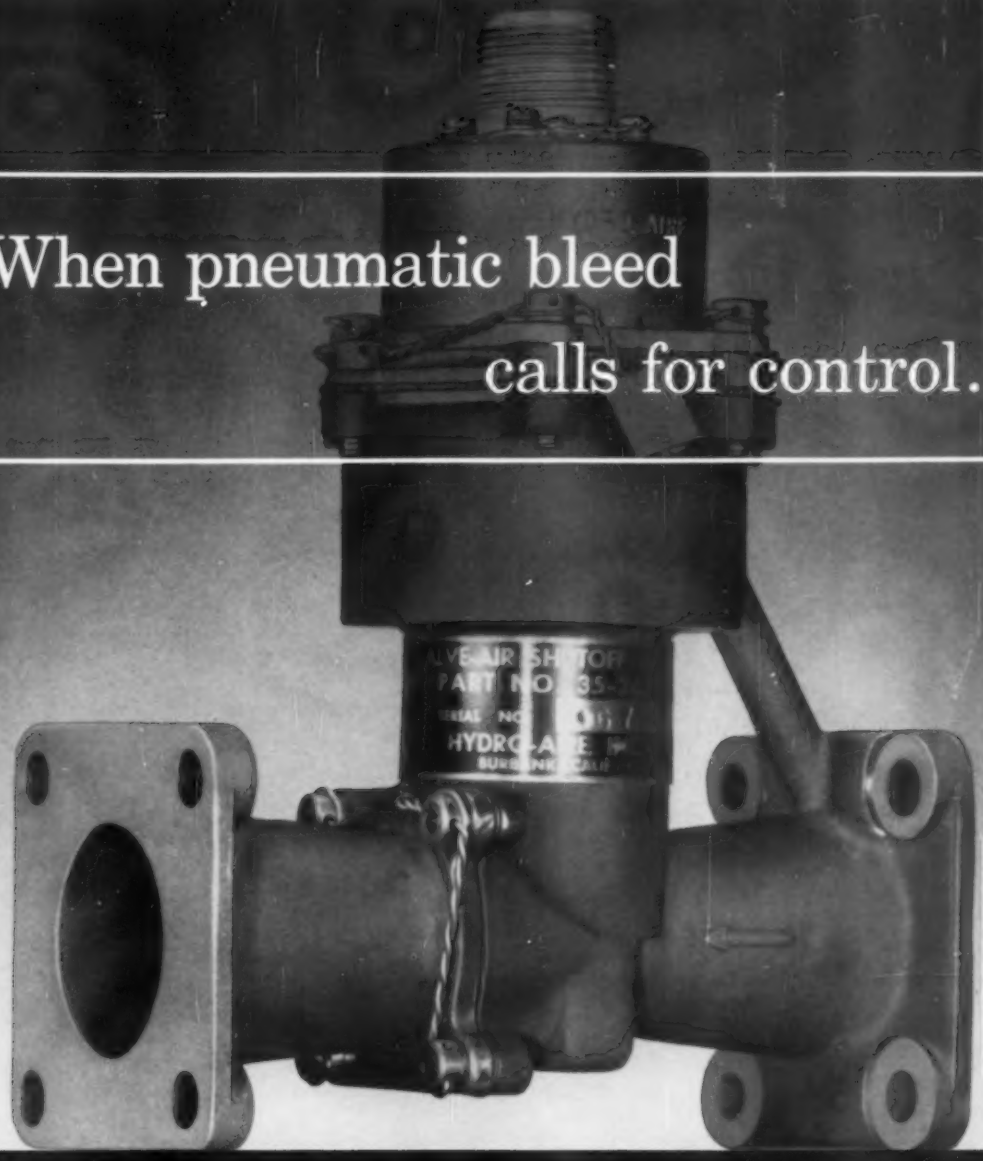
With high grade scientific and engineering ability needed as badly as it is today it is time that we considered salaries of these personnel (non-management) as well as those of management in their correct perspective. A number of organizations have been able to make quite significant technical progress due in part to a progressive management in some cases, but in others to exceptional technical ability in spite of a management of questionable integrity often concerned more with window dressing (large propaganda budgets) than true performance. Certainly actual overhead costs will be high when this includes salaries of highly overpaid management, when immense quantities of paper work (often of a highly duplicative nature) are involved and where turnover of technical personnel is quite high due in part to misrepresentation of technical positions in one way or another on the part of management, hiring of technical personnel for sub-professional work and allowing salary discrepancies (quite large in some cases) to exist for a given level of professional performance and ability in their organization. Management in many cases is all too ready to shout a crying need for technical personnel not always because shortages exist but primarily because they are seriously concerned that eventually salaries of this relatively new profession will become competitive with their own.

Edward Kramer
Cincinnati, Ohio



UNIVERSITY MICROFILM IN(

# When pneumatic bleed calls for control...



*Motor operated Hot Air Butterfly Valves*

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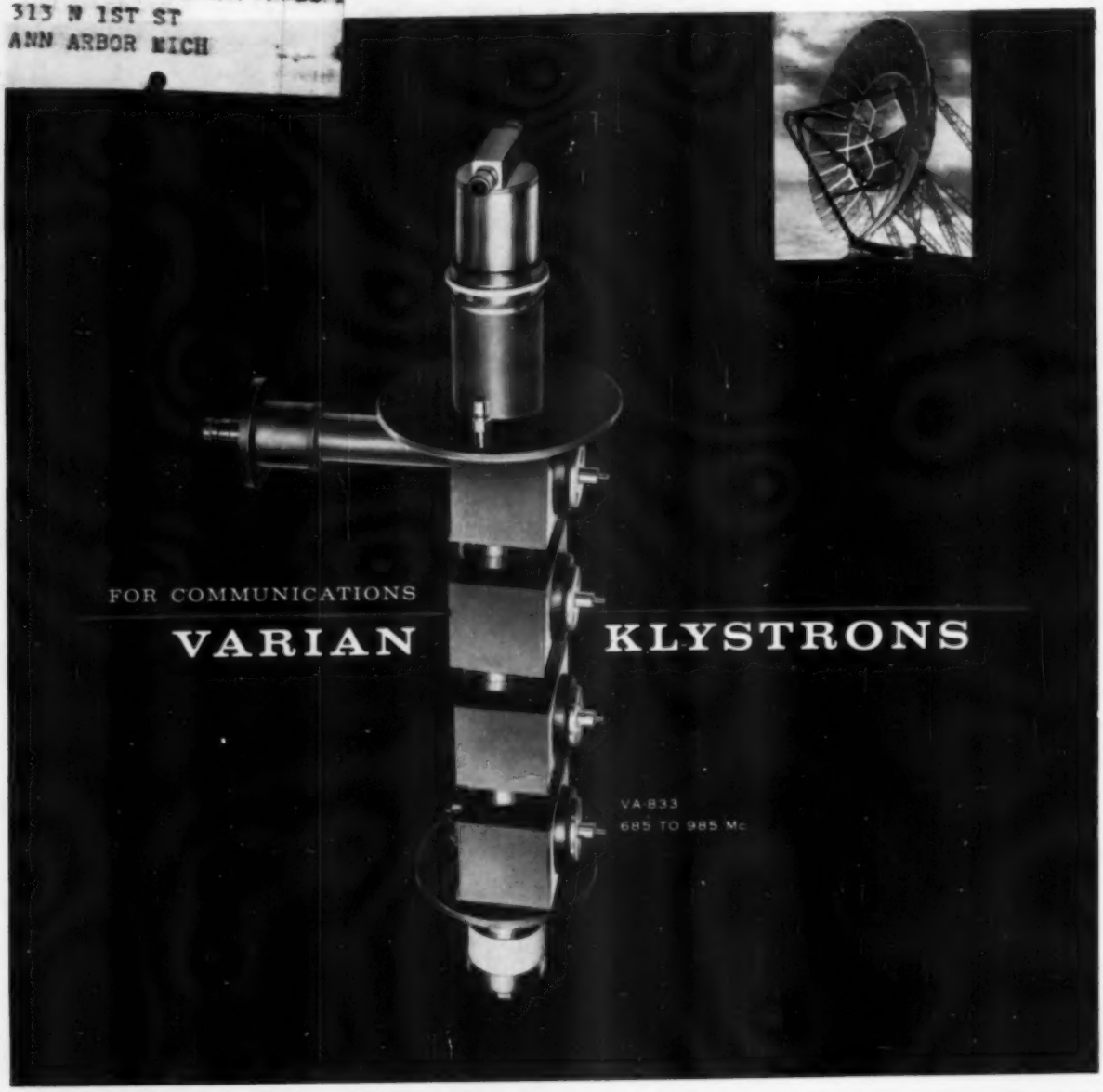


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